DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

USDOE Hanford 100 Area
100-HR-3 and 100-KR-4 Operable Units
Hanford Site
Benton County, Washington

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected interim remedial actions for portions of the USDOE Hanford 100 Area, Hanford Site, Benton County, Washington, which were chosen in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act of 1986* (SARA), and to the extent practicable, the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP). This decision is based on the administrative record for this site.

The Washington State Department of Ecology (Ecology) concurs on the selected remedy.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record of Decision (ROD), may present an imminent and substantial endangerment to public health, welfare, or the environment.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy is an interim action that involves removing hexavalent chromium from groundwater that discharges into the Columbia River. To intercept the chromium plumes, groundwater will be pumped from approximately 30 wells located along and inland from the river shoreline. The water will then be treated using an ion exchange treatment technology to remove chromium. The treated effluent will then be returned to the aquifer using injection wells located upgradient of the existing chromium plumes. The interim action includes monitoring of the groundwater near the river and the effluent from the treatment system to determine system performance in meeting the remedial action objectives for protection of the Columbia River. The interim action also involves institutional controls to protect human health from groundwater contaminants.

DECLARATION

This interim action is protective of human health and the environment, complies with Federal and State applicable or relevant and appropriate requirements directly associated with this action, and is cost-effective. This action utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable, given the limited scope of the action. This remedial action complies with the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume of contaminants as a principal element. Subsequent actions are planned to fully address the threats posed by these operable units.

Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Because this is an interim action Record of Decision (ROD), review of these operable units and the remedy will be ongoing as the Tri-Parties continue to develop and implement final remedial alternatives for the operable units and the 100 Area National Priority List (NPL) site.

028957

Signature sheet for the Record of Decision for the USDOE Hanford 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

John D. Wagoner _______________ 4/1/96
John D. Wagoner
Manager, Richland Operations
United States Department of Energy

Date

Signature sheet for the Record of Decision for the USDOE Hanford 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Chuck Clarke
Regional Administrator, Region 10
United States Environmental Protection Agency

3/26/96
Date

Signature sheet for the Record of Decision for the USDOE Hanford 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions between the United States Department of Energy and the United States Environmental Protection Agency, with concurrence by the Washington State Department of Ecology.

Michael A. Wilson 3/25/96

Michael Wilson   Date
Program Manager, Nuclear and Mixed Waste Program
Washington State Department of Ecology

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DECISION SUMMARY

I. SITE NAME, LOCATION, AND DESCRIPTION

The U.S. Department of Energy's Hanford Site was listed on the National Priorities List (NPL) in November 1989 under the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) as amended by the *Superfund Amendments and Reauthorization Act of 1986* (SARA). The Hanford Site was divided and listed as four NPL Sites: the 100 Area, the 200 Area, the 300 Area, and the 1100 Area.

The Hanford Site is a 560-square mile Federal facility located in southeastern Washington along the Columbia River. The region includes the incorporated cities of Richland, Pasco, and Kennewick (Tri-Cities) and surrounding communities in Benton, Franklin, and Grant counties (figure 1). The Hanford Site was established during World War II as part of the "Manhattan Project" to produce plutonium for nuclear weapons. Hanford Site operations began in 1943.

The 100 Area, which encompasses approximately 68 km^2 (26 mi^2) bordering the south shore of the Columbia River, is the site of nine retired plutonium production reactors. The groundwater impacted by operations associated with those 9 reactors has been divided into five operable units. Two of the five groundwater operable units are addressed in this Record of Decision.

Pre-1943 land use at Hanford was primarily grazing and agriculture with some traditional use by Native Americans. Historically groundwater use included domestic consumption, as well as other needs for the small agricultural communities, and by Native Americans. Currently groundwater is not used but is monitored to assess contaminant conditions. Existing land use in the 100 Area includes facilities support, waste management, and undeveloped land. Facilities support activities include operations such as water treatment and maintenance of the reactor buildings. The waste management land use designation results from former uncontrolled disposal activities in areas now known as "past-practice waste sites" located throughout the 100 Area. Lastly, there are undeveloped lands located throughout the 100 Area that comprise approximately 90 percent of the land area within the 100 Area. These areas are the least disturbed and contain minimal infrastructure.

The Hanford Reach of the Columbia River is the last free-flowing portion of the Columbia River in the United States above Bonneville Dam. The river contains the only remaining spawning habitat for native salmon on the main stem of the Columbia River in the United States. The river and associated riparian and upland areas are valued ecological and recreational resources. The Hanford Reach along the 100-HR-3 and 100-KR-4 Operable Units is currently being used for activities such as hunting, fishing, and water skiing. The Hanford Reach of the Columbia River: Comprehensive River Conservation Study and Environmental Impact Statement has identified much of Hanford Reach, including the 100 Area, for consideration as a designated recreational river under the *Wild and Scenic Rivers Act*.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

In anticipation of the NPL listing, DOE, EPA, and Ecology entered into a Federal Facility Agreement and Consent Order in May 1989 known as the Tri-Party Agreement. This agreement established a procedural framework and schedule for developing, implementing, and monitoring remedial response actions at Hanford. The agreement also addresses *Resource Conservation and Recovery Act* (RCRA) compliance and permitting.

In 1988, the Hanford Site was scored using EPA's Hazard Ranking System. As a result of the scoring, the Hanford Site was added to the NPL in November 1989 as four sites (the 100 Area, the 200 Area, the 300 Area, and the 1100 Area). Each of these areas was further divided into operable units (a grouping of individual waste units based primarily on geographic area and common waste sources). The 100 Area NPL site consists of the following operable units for contaminated sources such as soils, structures, debris, and burial grounds: 100-BC-1, 100-BC-2, 100-KR-1, 100-KR-2, 100-NR-1, 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-FR-1, 100-FR-2, 100-IU-1, 2, 3, 4, 5, and 6; and for contaminated groundwater: 100-BC-5, 100-KR-4, 100-NR-2, 100-HR-3, and 100-FR-3. This ROD addresses the chromium contaminated plumes in the 100-HR-3 and 100-KR-4 Operable Units.

The 100-HR-3 Operable Unit is located in the north-central part of the Hanford Site along the Columbia River. This operable unit includes the groundwater underlying the 100-D/DR and 100-H Reactor Areas and a portion of the 600 Area (figure 2). The 100-D/DR Area is the site of two deactivated reactors: the 100-D Reactor, which operated from 1944 to 1967, and the 100-DR Reactor, which operated from 1950 to 1965. The 100-H reactor operated from 1949 to 1965.

The 100-KR-4 Operable Unit is also located in the north-central part of the Hanford Site, upriver of 100-HR-3. The 100-KR-4 Operable Unit includes the groundwater underlying the 100-KR-1 and 100-KR-2 Operable Units (figure 3). The 100-K Area is the site of two deactivated reactors: the 100-K East Reactor, which operated from 1955 to 1971, and the 100-K West Reactor, which operated from 1955 to 1970.

During the years of reactor operations, large volumes of reactor coolant water containing chromium and radionuclides were discharged to retention basins for ultimate disposal in the Columbia River through outfall pipelines. Liquid wastes, containing significant quantities of chromium from reactor operations, were also discharged to the soil column at cribs, trenches, and french drains. Contaminant plumes in groundwater resulted from these former waste disposal practices. Groundwater contaminated with chromium is present beneath the 100-D/DR, 100-H, and 100-K Reactor areas and is migrating toward, and discharging into, the Columbia River. The groundwater upwells into the river through the riverbed with minor contributions from riverbank seepage.

Figure 1. Hanford Site.

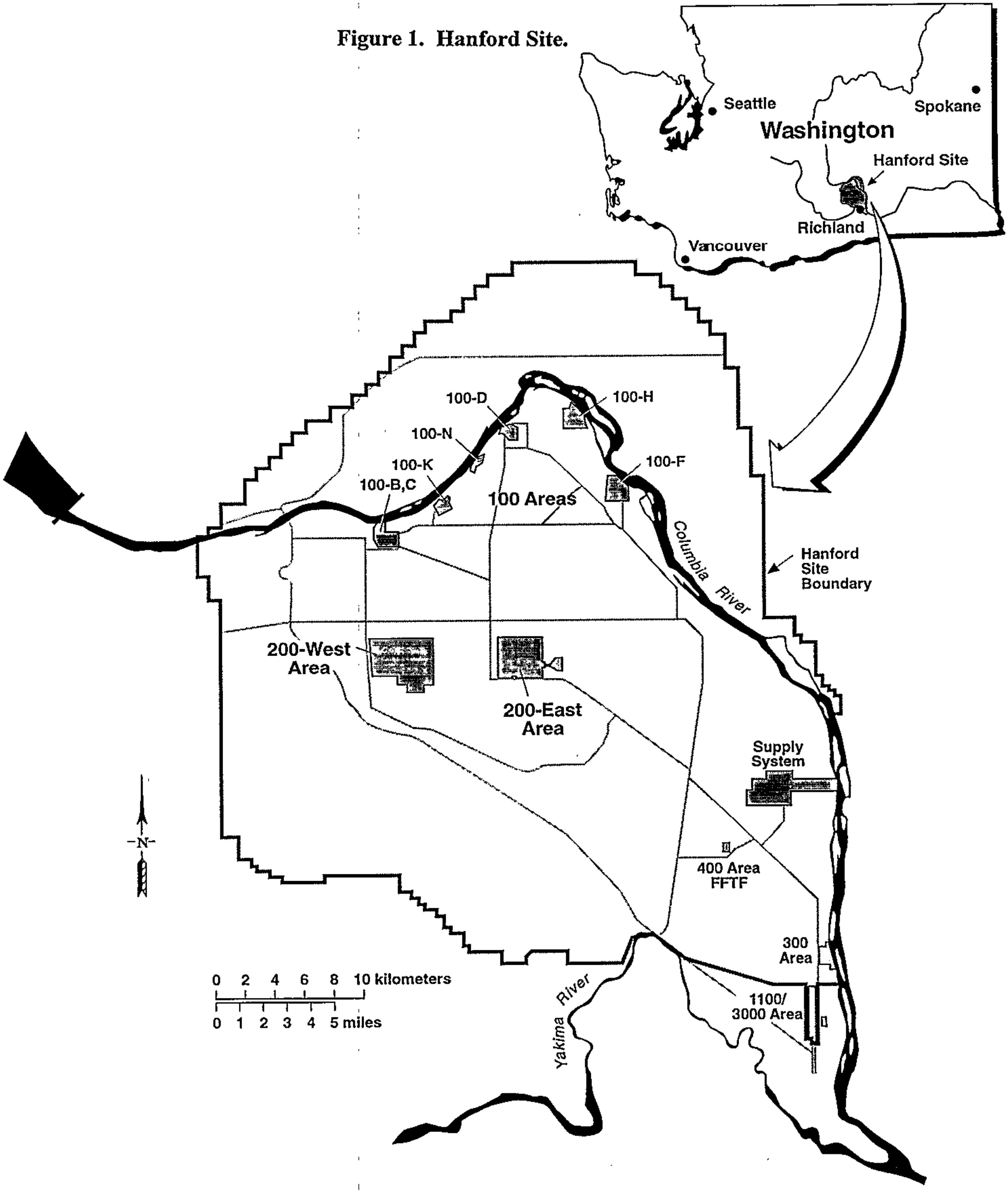


Figure 2. 100-HR-3 Operable Unit.

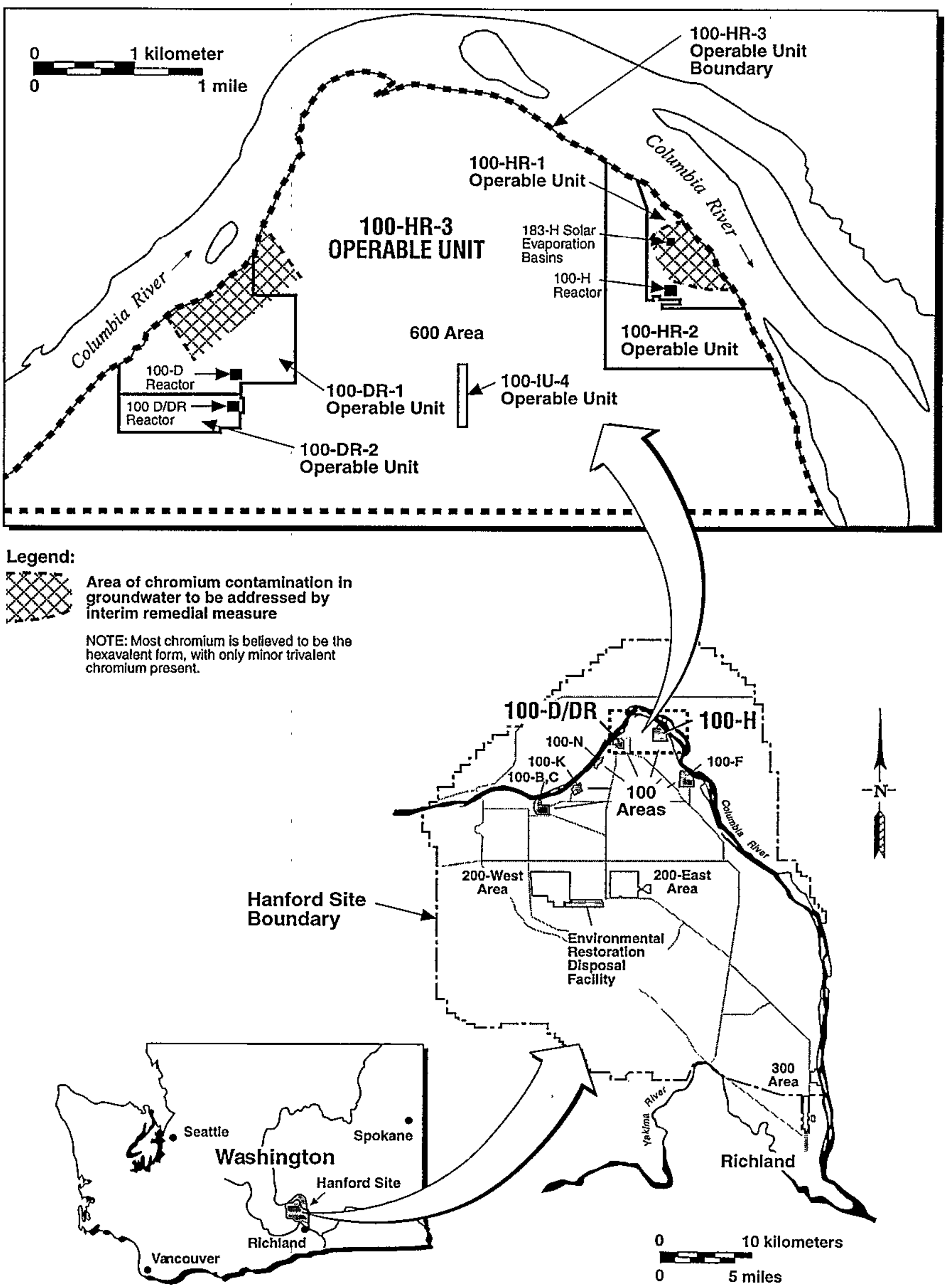
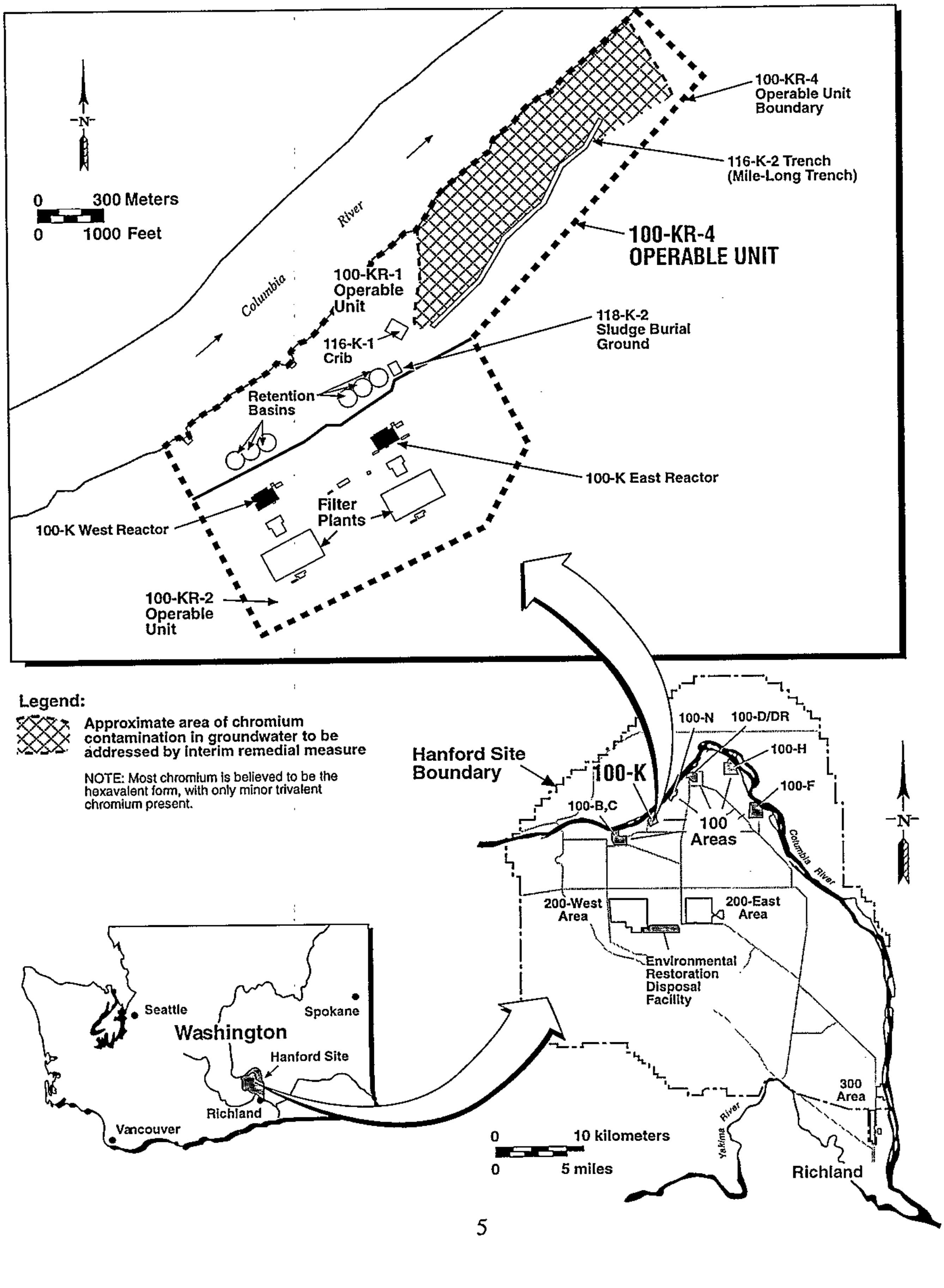


Figure 3. 100-KR-4 Operable Unit.



Prior to starting the "Limited Field Investigation" in 1992 in the 100-KR-4 and 100-HR-3 Operable Units, groundwater monitoring consisted of periodic sampling under programs set up by DOE Order 5400.1. These include the Operational Monitoring program conducted by the Maintenance and Operations contractor for the Site, and the Sitewide Environmental Surveillance program, which is conducted by Pacific Northwest National Laboratory. A limited record exists for groundwater conditions during the reactor operating years. Riverbank seepage monitoring was completed in 1984 and 1988 as part of the Sitewide Environmental Surveillance program. The following three paragraphs identify reactor-area specific activities that add to the data available from these sitewide programs.

At the 100-K Area, groundwater sampling was associated with operations at the 100-K East and 100-K West fuel storage basins. Some post-1959 data from several wells are available to describe conditions downgradient of the 116-K-2 trench used for liquid effluent disposal that included chromium.

For the 100-D/DR reactor area (100-HR-3 Operable Unit), historical data describing conditions during reactor operations are limited to several wells that were constructed in 1960. Quarterly sampling was started in 1991 under the RCRA/Operational program for monitoring liquid effluent discharge to 100-D Ponds. An infiltration experiment was conducted in 1967 that created a groundwater mound in the vicinity of the coolant water retention basins. The results may provide an analog for the unmonitored conditions that prevailed during reactor operating years.

A similar database exists for the 100-H Area (100-HR-3 Operable Unit). Monitoring of the 183-H Solar Evaporation Basins facility occurred between 1973 and 1985, when monitoring was substantially increased under the RCRA/Operational program. A comprehensive database exists to describe the contaminant plume, which includes chromium, associated with the 183-H facility for years after 1985.

The technical information baseline for the RI/FS associated with each operable unit was augmented substantially in 1992 with the installation of new monitoring wells and subsequent quarterly sampling as part of the limited field investigation. A comprehensive riverbank seepage sampling project was completed in late 1991, which helped relate contamination along the shoreline to groundwater contamination underlying the reactor areas. RI/FS characterization activities that followed the four quarters of sampling conducted during the limited field investigation consist of semiannual well sampling, annual riverbank seepage sampling, and periodic Columbia River substrate sampling. Water table elevations were measured at periodic intervals to show the seasonal ranges in flow direction and gradients.

As a result of the discharge of groundwater from the operable units into the river, chromium, a metal that is toxic to aquatic organisms in low concentrations, poses a risk to aquatic organisms in the Columbia River adjacent to the 100-D/DR, 100-H, and 100-K Areas. The most toxic form of chromium, hexavalent chromium, readily dissolves in water and, therefore, moves freely with groundwater. Hexavalent chromium has been detected in groundwater and in the groundwater/river interface where groundwater upwells into the river. Once discharged to the river, it is easily assimilated by aquatic organisms, some of which are adversely affected. Trivalent chromium is less soluble and less toxic, and is not easily transported by groundwater. Most chromium in groundwater at the Hanford Site is hexavalent chromium, because of the original sources and prevailing geochemical conditions.

In August 1994, a pilot-scale treatability test began at the 100-D/DR Area, to assess the effectiveness of an ion exchange treatment system to remove hexavalent chromium from groundwater. Through July 1995, this pump-and-treat system has extracted more than 4 million gallons (15 million liters) of groundwater and has removed more than 38 pounds (17 kilograms) of chromium. This system is successful in removing chromium from extracted groundwater at 100-D/DR, and indicates that an ion exchange treatment system can be a successful groundwater treatment technology for chromium in the 100 Area.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

The DOE, Ecology, and EPA developed a Community Relations Plan in April 1990 as part of the overall Hanford Site restoration. The Plan was designed to promote public awareness of the investigations and public involvement in the decision-making process. The Plan summarizes known concerns based on community interviews. Since that time several public meetings have been held and numerous fact sheets have been distributed in an effort to keep the public informed about Hanford cleanup issues. The Plan was updated in 1993 to enhance public involvement and is currently undergoing an additional update.

The 100 Area Focused Feasibility Study Document and Proposed Plans for 100-HR-3 and 100-KR-4 were made available to the public in both the Administrative Record and the Information Repositories maintained at the locations listed below. These documents underwent a 45 day public comment period from September 11, 1995 to October 25, 1995.

ADMINISTRATIVE RECORD (Contains all project documents)

U.S. Department of Energy
Richland Field Office
Administrative Record Center
740 Stevens Center
Richland, Washington 99352

EPA Region 10
Superfund Record Center
1200 Sixth Avenue
Park Place Building, 7th Floor
Seattle, Washington 98101

Washington State Department of Ecology
Administrative Record
300 Desmond Drive
Lacey, Washington 98503-1138

INFORMATION REPOSITORIES (Contain limited documentation)

University of Washington
Suzzallo Library
Government Publications Room
Mail Stop FM-25
Seattle, Washington 98195

Gonzaga University
Foley Center
E. 502 Boone
Spokane, Washington 99258

Portland State University
Branford Price Millar Library
Science and Engineering Floor
SW Harrison and Park
P.O. Box 1151
Portland, Oregon 97207

DOE Richland Public Reading Room
Washington State University, Tri-Cities
100 Sprout Road, Room 130
Richland, Washington 99352

Notice of the public comment period and availability of documents for review was published in the Seattle PI/Times, the Spokesman Review-Chronicle, the Tri-City Herald, and the Oregonian on September 10 and 11, 1995. The notice also ran throughout the week of September 10 in the various papers published by the Hood River News. In addition a 2-page focus sheet that summarized the Proposed Plans was mailed to an "interested in Hanford" mailing list of about 4,700. That mailing list included the members of the Hanford Advisory Board (a citizen / stakeholder cleanup advisory board), Native American Tribes with reserved treaty rights to Hanford-related resources, and Natural Resource Trustees. The Proposed Plans were faxed to participants in the Hanford Natural Resource Trustee Council (which includes the Tribes) on August 21-22, 1995. Focus sheets and Proposed Plans were mailed to a number of individuals in response to requests during the comment period. The Proposed Plans and focus sheet identified that a public meeting would be held upon request. Such a request was received from the Columbia River United citizen stakeholder group located in Hood River, Oregon. Per their request, a meeting was held October 18, 1995 that discussed the proposed actions relative to other Hanford groundwater and Columbia River issues. At the meeting, representatives from DOE, EPA and Ecology provided information about this and related projects and answered questions about the projects. A response to the comments received during the public comment period is included in the Responsiveness Summary, which is attached as Appendix A to this ROD. This decision document presents the selected interim remedial action for the groundwater at the 100-HR-3 and 100-KR-4 Operable Units at the Hanford Site in Richland, Washington. The selected interim remedy is chosen in accordance with CERCLA, as amended by SARA, and to the extent practicable, the National Contingency Plan (NCP). The decision for these operable units is based on the Administrative Record.

IV. SCOPE AND ROLE OF RESPONSE ACTION WITHIN SITE STRATEGY

The interim action is expected to provide adequate protection of human health and ecological receptors in the Columbia River and will continue until implementation of the final remedy for the 100-HR-3 and 100-KR-4 groundwater operable units, or until such time that the DOE demonstrates to Ecology and the EPA that no further interim action is required. This interim action is expected to become part of the final remedial action for the 100-HR-3 and 100-KR-4 Operable Units. As with the remedy selection for interim action, final remedy selection will occur only after taking public comment into consideration.

In addition to this action for the 100-HR-3 and 100-KR-4 Operable Units, plans are underway to address waste sites that are the historic sources of groundwater contamination. Surface waste sites that are within operable units 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-KR-1 and 100-KR-2 received wastes during previous operation of the reactors and their support facilities. Cleanup of high priority liquid effluent waste sites in the 100-DR-1 and 100-HR-1 Operable Units were addressed in a September 1995 interim action Record of Decision. The 100-DR-2, 100-HR-2, 100-KR-1 and 100-KR-2 Operable Units will be the subject of future response actions. The 100-IU-4 Operable Unit upgradient of 100-HR-3 includes the former Sodium Dichromate Barrel Landfill, which was previously used to dispose of empty crushed barrels. The 100-IU-4 Operable Unit was remediated in April 1992 through an Expedited Response Action and a no further action final ROD was signed in February 1996.

Because this is an interim action ROD, review of these operable units and the remedy will be ongoing as the Tri-Parties continue to develop and implement final remedial alternatives for the operable units and the 100 Area NPL site. Because this remedy will result in hazardous substances remaining on-site above health-based levels, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment.

V. SUMMARY OF SITE CHARACTERISTICS

5.1 Site Geology and Hydrogeology

The Hanford Site is located in the Pasco Basin, a topographic and structural basin situated in the northern portion of the Columbia Plateau. The plateau is divided into three general structural subprovinces: the Blue Mountains; the Palouse; and, the Yakima Fold Belt. The Hanford Site is located in the eastern portion of the Yakima Fold Belt.

5.1.1 Geology

The 100 Area is located in the northern portion of the Hanford Site, adjacent to the Columbia River. The geology of the 100 Area is similar to much of the rest of the Hanford Site, which generally consists of three distinct geologic formations. The oldest and deepest formation consists of a thick series of basalt flows and interbeds that have been warped and folded. The top of the basalt in the 100 Area ranges in elevation from 46 m (150 ft) near the 100 H Area to 64 m (210 ft) below sea level west of the 100 K Area. The Ringold Formation overlies the Columbia River Basalts and is up to 185 m (about 600 ft) thick in the Pasco basin. The Ringold Formation is made up of sedimentary deposits which consist of interbedded clay, silt, fine to coarse sand, and gravel. The uppermost formation is referred to as the Hanford Formation. It consists of sand and gravel deposited by catastrophic floods during the last glacial episode. In the 100 Area, the Hanford Formation consists primarily of the Pasco Gravel Facies, with local occurrences of the sand-dominated or slackwater deposits.

The 100 K Area differs geologically from the surrounding area because the Ringold Formation is exposed along the bank of the Columbia River and up to 366 m (1200 ft) inland. Coyote Rapids, immediately upstream of the 100 K Area consists of cemented Ringold material. The contact between the Hanford Formation and the Ringold Formation is generally noted by an iron staining and an increase in cementation. The Hanford Formation underlying the 100 K Area is a wedge that increases in thickness away from the Columbia River. It varies in thickness from 0 to about 37 m (120 ft) near the southwest corner of the K Area. The Hanford Formation in the vicinity of the 100 K Area consists mainly of gravels.

Underlying the 100 H & D Areas, a lacustrine mud unit up to 30 m (100 ft) thick forms the base of the Ringold Formation. Overlying the mud unit, fluvial sands and gravels interbedded with overbank and lacustrine sediments comprise the remaining Ringold Formation. The Ringold/Hanford contact is highest west of the 100 H Area and slopes toward the Columbia River to the east. The Hanford Formation thickness ranges from near 0 to 24 m (80 ft). The unit is thickest in the west central portion of the 100 HR-3 Operable Unit. In this area the Hanford Formation consists of unconsolidated gravels in a matrix of fine to coarse sand.

5.1.2 Hydrogeology

Underlying the 100 Area the uppermost aquifer is referred to as the unconfined aquifer. This aquifer is open to the vadose zone and is hydraulically connected to the Columbia River. Below the unconfined aquifer there exists multiple confined aquifers. The confined aquifers to date have received very little contamination due to an upward hydraulic gradient.

The unconfined aquifer system underlying the 100 K and D Areas is comprised exclusively of Ringold Formation fluvial sand and gravel. Groundwater flow direction is north-northwest towards the Columbia River. The mean hydraulic conductivity of the Ringold Formation is about 32 ft/day. Groundwater elevation across the K Area ranges from about elev. 382 to elev. 392 ft. Across the D Area groundwater elevation ranges from about elev. 381 to elev. 386 ft. In the 100 H Area the unconfined aquifer occurs predominantly in the Hanford Formation. Groundwater elevation ranges from about elev. 374 to elev. 377 ft. The saturated portion of the Hanford Formation is about 13 to 24 ft thick across this area. Flow direction is northeast towards the Columbia River. The mean hydraulic conductivity for the H Area is about 100 ft/day.

5.2 Columbia River Water Quality

Surface water at the 100 Areas of the Hanford Site is limited to the Columbia River and springs along the riverbank. The Columbia River is the second largest river in North America and the dominant surface-water body on the Hanford Site. The existence of the Hanford Site has precluded development of this section of river for irrigation and power, and the Hanford Reach (the free flowing section of the Columbia River beginning at Priest Rapids Dam and ending at Lake Wallula) is now being considered for designation as a National Wild and Scenic River as a result of congressional action in 1988 (*Public law 100-605*).

Washington State has classified the stretch of the Columbia River from Grand Coulee to the Washington-Oregon border, which includes the Hanford Reach, as Class A, Excellent. Class A waters are to be suitable for essentially all uses, including raw drinking water, recreation, and wildlife habitat.

The seepage of groundwater, or springs, into the Columbia River has been known to occur for many years. These relatively small springs flow intermittently, apparently influenced primarily by changes in river level. Hanford-origin contaminants have been documented in these groundwater discharges along the Hanford Reach.

5.3 Groundwater System

Groundwater in the unconfined aquifer at the Hanford Site generally flows from recharge areas in the elevated region near the western boundary of the Hanford Site toward the Columbia River on the eastern and northern boundaries. The Columbia River is the primary discharge area for the unconfined aquifer. Natural areal recharge from precipitation across the entire Hanford Site is thought to range from almost 0 to 10 cm (0 to 4 in.) per year, but is probably less than 2.5 cm (1 in.) per year. Since 1944, the artificial recharge from Hanford Site wastewater disposal operations has been significantly greater than the natural recharge. An estimated 1.68×10^{12} L (4.4×10^{11} gallons) of liquid was discharged to disposal ponds, trenches, and cribs. Now that liquid discharges from reactor processes has stopped, groundwater flow has since returned to its pre-Hanford flow direction and gradient in the 100-HR-3 and 100-KR-4 Operable Units.

5.4 Groundwater Data Summary

The primary purpose of the limited field investigation at the Operable Units was to collect sufficient data to determine if the groundwater is contaminated to the extent that an interim remedial action was warranted. The limited field investigation was designed to augment existing historical groundwater data mentioned in Section II. The data gathered during the limited field investigation were also used to conduct a qualitative risk assessment for human and ecological receptors, and to evaluate remedial alternatives.

As part of the limited field investigation, 22 new groundwater wells were installed (in addition to the existing 42 wells) in the 100-HR-3 Operable Unit and 7 new groundwater wells were installed (in addition to the existing 12 wells) in the 100-KR-4 Operable Unit. These wells were constructed to help define groundwater quality in areas downgradient of the priority waste sites in the area that are sources of the contaminants, and estimate groundwater quality at locations where human and ecological receptors may be exposed to groundwater.

Groundwater samples were collected from these new wells and existing monitoring wells (100-HR-3, figure 4; 100-KR-4, figure 5). A total of 262 samples from 100-HR-3 and 82 samples from 100-KR-4, exclusive of duplicates and splits, were collected over four rounds of sampling (September 1992 to June 1993 for 100-KR-4, and May 1992 to March 1993 for 100-HR-3). These samples were analyzed for organic, inorganic, and radioactive constituents. Soil samples were collected during well-drilling activities and analyzed for physical properties. Tables 1 through 3 (100-HR-3), and table 4 (100-KR-4) present the maximum concentrations of radiological and nonradiological chemicals in groundwater, in springs and seeps, and in the Columbia River within and adjacent to these areas. These maximum concentrations were used to evaluate risks to receptors. Data from near-river wells were used to evaluate ecological risk, and data from all wells were used to evaluate human health risk.

During March of 1995 pore water samples were collected in the river substrate adjacent to the 100-H Area. Results indicated that chromium is present in the river substrate at levels of concern. Similar data are being collected at other reactor areas. Additionally, sampling points are being successfully installed along the shoreline to evaluate the river-groundwater interface. These new data will support the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP).

5.5 Ecological Description

An 18 mile stretch of the Columbia River is located within the 100 Area. The Columbia River corridor is a valued ecological area within the Hanford Site. Semi-arid land with a sparse covering of cold desert shrubs and drought-resistant grasses dominates the Hanford landscape. Forty percent of the area's annual average of six and one quarter inches of rain occurs between November and January. Numerous ecological studies have characterized the biological resources of the Hanford Site, including the terrestrial, riparian, and aquatic habitats.

Because this interim action involves activities located on upland habitat, adjacent to riparian and aquatic areas, and affects the chemical and hydrological regime in the near-river environment, the potential list of species that could be affected includes potentially all species associated with the Hanford site, both resident and migratory. Table 5 lists species of concern found or potentially occurring on the Hanford Site, and table 6 lists known fish species in the Hanford Reach of the Columbia River. Portions of the 100-HR-3 and 100-KR-4 lie within the 100-year flood plain (figure 6). There is a band of wetland habitat adjacent to the Columbia River that varies from very thin in 100-KR-4 to very wide in portions of 100-HR-3.

5.6 Cultural Resources Review

Both 100-HR-3 and 100-KR-4 are in areas rich with cultural resources. The 100-K Area contains a number of archaeological and ethnohistoric sites that range in age from 9,000 years ago to the mid-nineteenth century. The 100-K area is considered extremely sensitive as a Native American-related cultural resource. Two individual sites within the 100-K Area are individually eligible for the National Register of Historic Places while others are included in the Ryegrass Archaeological District. Along the rapids associated with the 100-K Area, Smohalla, Prophet of the Wanapum people performed the first *washat*, the dance ceremony that has become central to the Seven Drums or Dreamer religion. This religion spread to many neighboring Tribes and is currently practiced in some form throughout the interior Northwest. Furthermore, a Wanapum cemetery exists in the 100-K Area.

Surveys for 100-HR-3 have located 25 prehistoric sites and 58 historic sites. Six of the prehistoric sites have been evaluated for and found eligible for listing to the National Register of Historic Places.

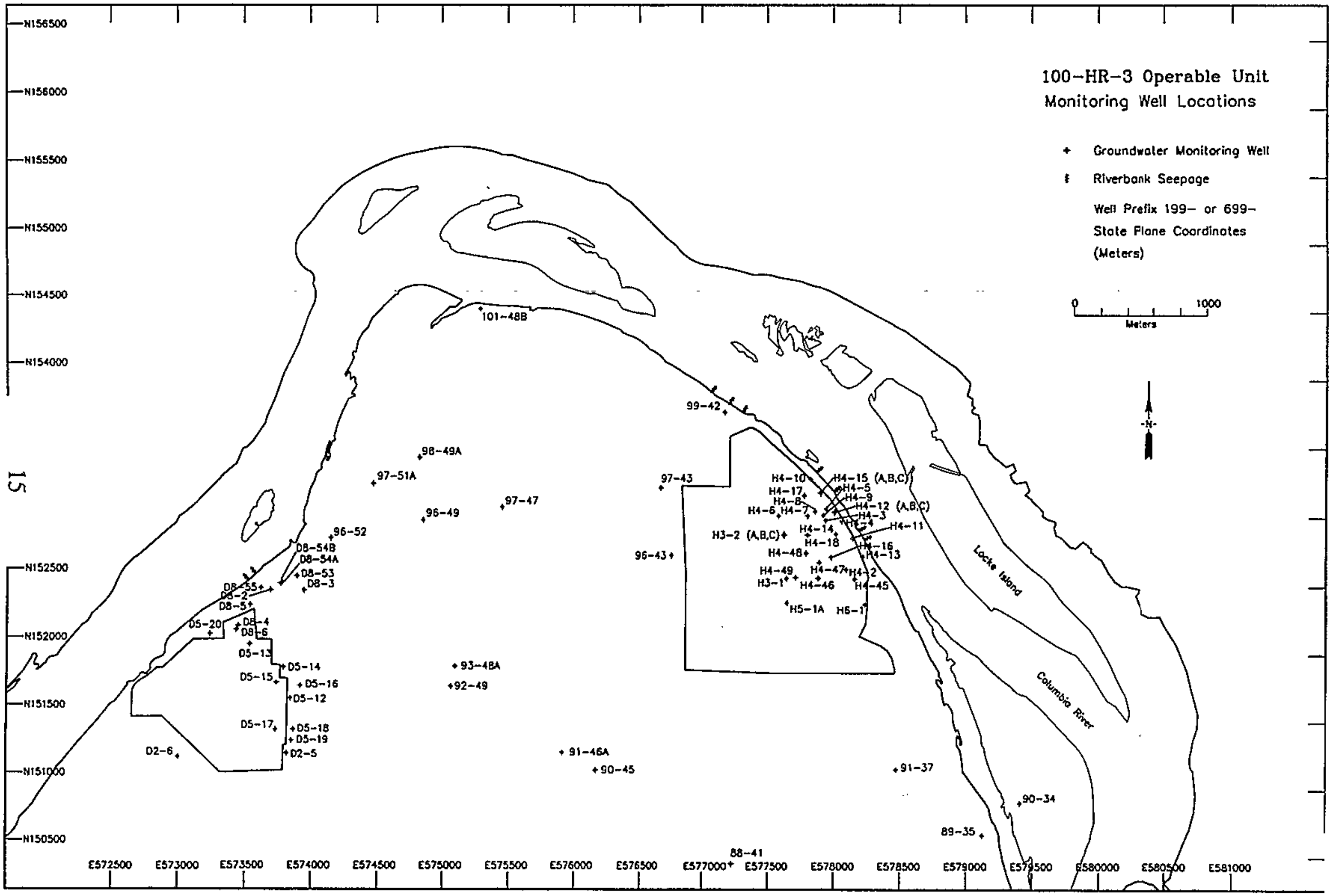


Figure 4. Well Location Map for the 100-HR-3 Operable Unit

Figure 5. Well Location Map for the 100-KR-4 Operable Unit.

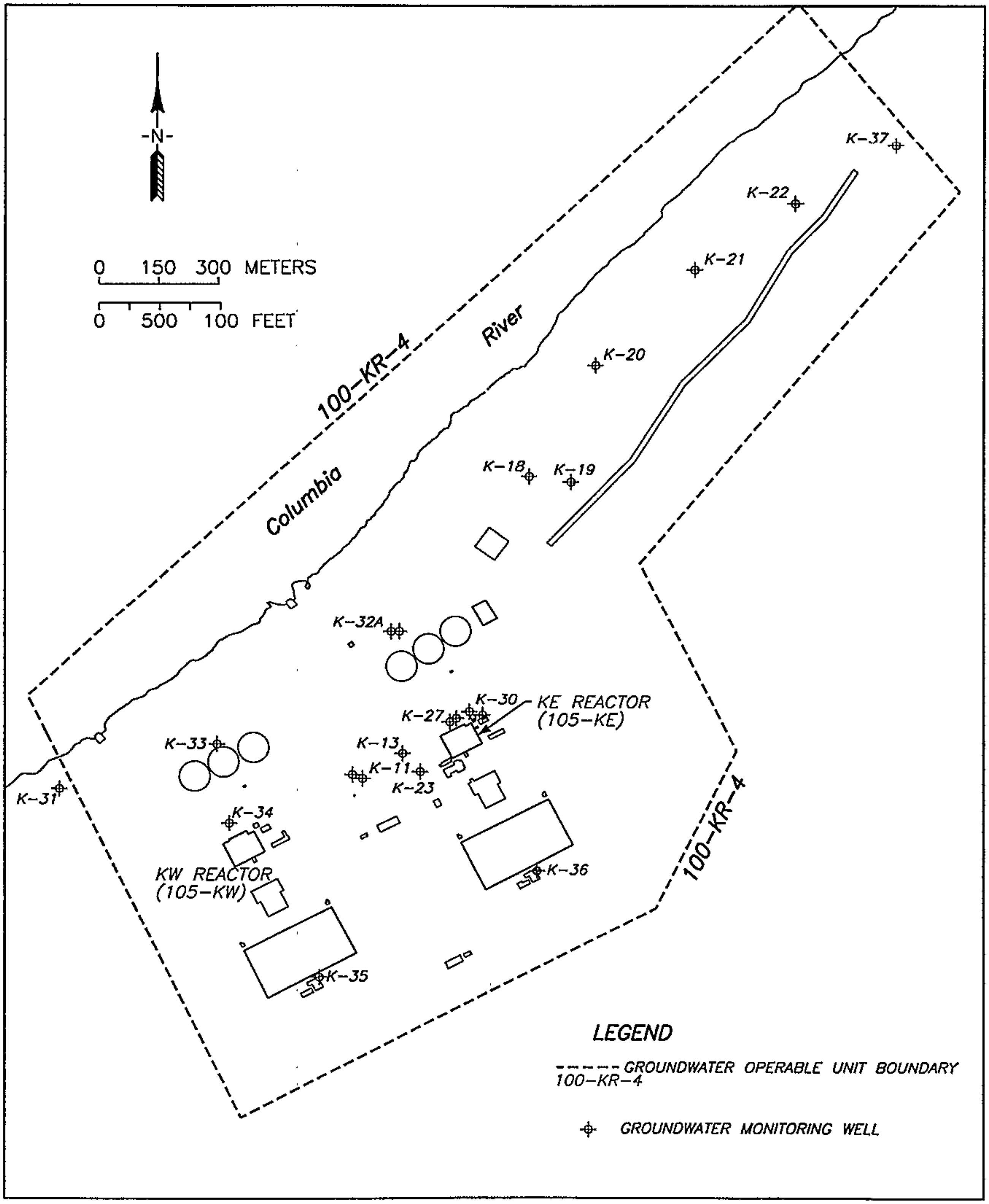


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Figure 6. Columbia River Flood Plain.

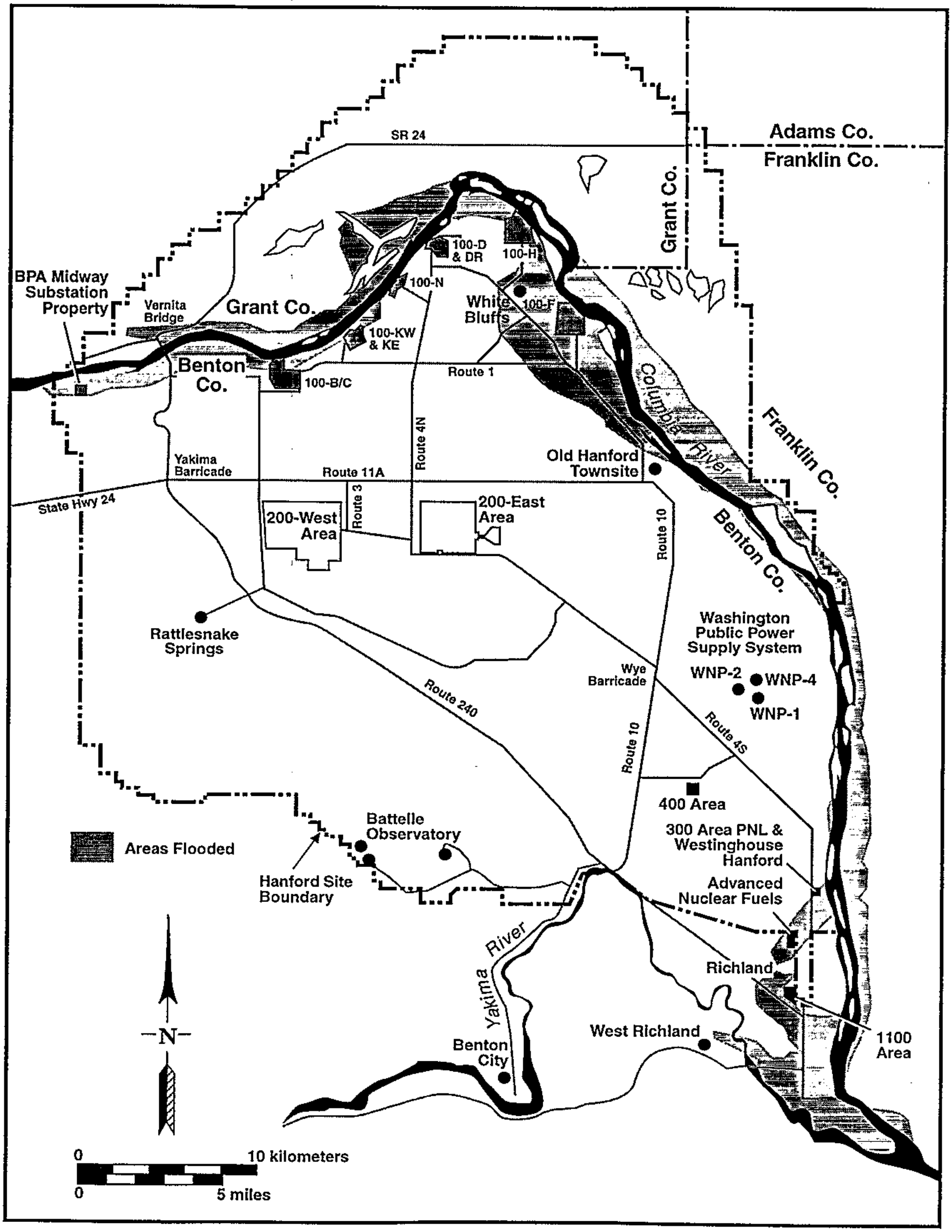

Table 1. Maximum Concentration Summary for Contaminants of Potential Concern in the 100-D/DR Area.

Groundwater Contaminants	All Groundwater Wells	Near-River Groundwater Wells	D/DR Area Springs	D/DR Area Columbia River	MCL (pCi/L or mg/L)
Radionuclides (pCi/L)					
Tritium	78,000	19,000	3,100	<200	20,000[a]
Strontium-90	41(J)	7.6	4.5	<1	8[a]
Uranium 233/234	1.5	1.1	1.0[c]	0.33[c]	NA
Uranium 238	1.4	1.1	1.0[c]	0.33[c]	NA
Inorganics (mg/L)					
Barium	0.164	0.092	0.055	0.026	2.0[a]
Chromium[b]	2.09	0.44(J)	0.12	0.009(U)	0.1[a,b]
Iron	0.550	0.550	0.072	0.102	NA
Manganese	0.19	0.056	0.004(B)	0.007(U)	NA
Vanadium	0.020	0.020	0.005	(U)	NA
Organics (mg/L)					
Bis(2-ethylhexyl)phthalate	0.003	0.003	(U)	(U)	NA
Anions (mg/L)					
Ammonia as N	0.75	0.26	0.1(J)	<0.5(UJ)	NA
Nitrate as N	32.7	14.1	0.68	(U)	10[a]
Sulfide	1	1	(U)	(U)	NA

a 40 CFR 141 (Primary MCL). MCLs presented for comparison purposes.
b Sample Value reported is for total chromium. MCL is for hexavalent chromium.
c Sample Value reported is for total uranium.
(J) Estimated value.
(B) Analyte detected at a concentration below the contract required detection limit, but above the instrument detection limit.
(U) Undetected.
NA Not applicable.
Near-River wells were: 199-D5-20, -D8-4, -D8-5, -D8-53, -D8-54A, -D8-55.

Table 2. Maximum Concentration Summary for Contaminants of Potential Concern in the 100-H Area.

Groundwater Contaminants	All Groundwater Wells	Near-River Groundwater Wells	H Area Springs	H Area Columbia River	MCL (pCi/L or mg/L)
Radionuclides (pCi/L)					
Tritium	11,000	7,100	3,800(J)	400(J)	20,000[a]
Carbon-14	72	72	NA	NA	2,000[d]
Strontium-90	33	33	12.7	0.7(J)	8[a]
Technetium-99	2,270	500	12	3.4	900[e]
Uranium-233/234	26.8	26.8	NA	NA	NA
Uranium 235	2.43	2.43	1.22[c]	0.53[c]	NA
Uranium-238	18.6	18.6	1.22[c]	0.53[c]	NA
Americium-241	0.28(J)	0.28(J)	NA	NA	NA
Inorganics (mg/L)					
Barium	0.14	0.10	0.054	0.031	2.0[a]
Chromium[b]	0.49	0.49	0.052	0.006(U)	0.1[a,b]
Iron	5.4	1.5	0.924	0.183	NA
Manganese	0.18	0.002(B)	0.038	0.012(B)	NA
Organics (mg/L)					
Chloroform	0.053	0.031	NA	NA	NA
Anions (mg/L)					
Ammonia as N	0.29	0.29	(U)	(U)	NA
Fluoride	1.3	0.21	0.21	0.45	4.0[a]
Nitrate as N	170	32	1.01	0.12	10[a]
Sulfide	1	1	(U)	(U)	NA

a 40 CFR 141 (Primary MCL). MCLs presented for comparison purposes.
b Sample Value reported is for total chromium. MCL is for hexavalent chromium.
c Value reported is for total Uranium.
d Calculated based on annual average concentration yielding 4 mrem/yr for 2 liter/day daily intake (National Interim Primary Drinking Water Regulations), EPA
e State Advisory Level from State of Washington Department of Health, Procedures and References for the Determination of State Advisory Levels for Drinking Water Contaminants (March 1991).
(J) Estimated value.
(B) Analyte detected at a concentration below the contract required detection limit, but above the instrument detection limit.
(U) Undetected.
NA Not Applicable or Not Available.
Near-River wells were: 199-H4-4, -H4-5, -H4-10, -H4-11, -H4-12A, -H4-13, -H4-15A, -H4-45, -H6-1.

Table 3. Maximum Concentration Summary for Contaminants of Potential Concern in the 600 Area Between the 100-D/DR and 100-H Areas.

Groundwater Contaminants	All Groundwater Wells	Near-River Groundwater Wells	600 Area Springs	600 Area Columbia River	MCL (pCi/L or mg/L)
Radionuclides (pCi/L)					
Tritium	11,000	NA	NA	NA	20,000[a]
Inorganics (mg/L)					
Arsenic Chromium[b]	0.012 0.17	NA NA	NA NA	NA NA	0.05[a] 0.1[a,b]

a 40 CFR 141 (Primary MCL). MCLs presented for comparison purposes.

b Sample value reported is for total chromium. MCL is for hexavalent chromium.

NA Not Available

Table 4. Maximum Concentration Summary for Contaminants of Potential Concern in the 100-K Area.

Groundwater Contaminants	All Groundwater Wells	Near-River Groundwater Wells	K Area Springs	K Area Columbia River	MCL (pCi/L or mg/L)
Radionuclides (pCi/L)					
Tritium	1,900,000	35,000	8,900	ND	20,000[a]
Carbon-14	23,000	16,000	NA	NA	2,000[a]
Strontium-90	36	36	8.8	0.7(J)	8[a]
Technetium-99	46	11(R)	5.2	2.0	900[d]
Uranium-233/234	3.3	2.3	NA	NA	NA
Uranium-235	0.3	0.2(J)	NA	NA	NA
Uranium-238	2.6	1.9	1.1[c]	0.5[c]	NA
Inorganics (mg/L)					
Aluminum	0.844(J)	0.072(B)	0.225	ND	NA
Arsenic	0.010	0.007(B)	NA	NA	0.05[a]
Cadmium	0.002	0.002(B)	ND	ND	0.005[a]
Chromium[b]	1.95	0.261	0.069	ND	0.1[a,b]
Iron	5.43(J)	1.23	0.243	0.171	NA
Lead	0.008	0.006(J)	NA	NA	0.015[e]
Manganese	0.070	0.070	0.009(B)	0.020	NA
Nickel	0.019	0.010	ND	ND	NA
Silver	0.007(B)	0.005(B)	0.006(B)	ND	0.10[a]
Vanadium	0.024(B)	0.019(B)	0.011(B)	ND	NA
Zinc	0.461(B)	0.461(B)	ND	0.006(B)	NA
Organics (mg/L)					
Chloroform	0.017	0.017	NA	NA	NA
Trichloroethene	0.019	0.019	NA	NA	0.005[a]
Anions (mg/L)					
Chloride	21.6	21.6	6.01	0.86	NA
Nitrate/Nitrite	26	26	1.47(J)	0.5(J)	10[a]

a 40 CFR 141 (Primary MCL). MCLs presented for comparison purposes.
b Sample value reported is for total chromium.
c Value for total uranium reported.
d Calculated based on annual average concentration yielding 4 mrem/yr for 2 liter/day daily intake (National Interim Primary Drinking Water Regulations).
e Action level per 40 CFR 141, Subpart I.
(B) Concentration below the contract required detection limit but above the instrument detection limit.
(J) Estimated value.
(R) Rejected during data validation due to frequency of instrument calibration.
NA Not Available or Not Applicable.
ND Not detected.
Near-River wells were: 199-K-13, -K-18, -K-19, -K-20, -K-21, -K-22, -K-31, -K-32A, -K-33, -K-34, -K-37.

Table 5. Threatened and Endangered Species Potentially Found on the Hanford Site

Species	Notes
Endangered Vascular Plants	
Persistentsepal yellowcress *(Rorippa columbiae)*	Known to have a scattered distribution because of specialized habitat requirements or habitat loss; generally occurs in marshy places; known to inhabit wet shoreline of Hanford Reach in Benton County.
Northern Wormwood *(Artemisia campertris ssp borealis var workskioldii)*	Rare, local endemic species near the river; not known from Hanford but reported just to the north near Beverly, Grant County.
Threatened Vascular Plants	
Columbia milk-vetch *(Astragalus columbianus)*	Locally endemic to area near Priest Rapids Dam; could potentially occur in Northwest portion of Hanford along the Columbia River.
Dwarf Evening Primrose *(Camissonia (=Oenothera) pygmaea)*	Has been found at Hanford on mechanically disturbed areas.
Hoover's desert parsley *(Lomatium tuberosum)*	Locally endemic to south-central Washington, including Benton County; known to inhabit rocky hillsides.
Endangered Birds	
[1]Aleutian Canada goose *(Branta canadensis leucopareia)*	Only incidental occurrence at Hanford.
American white pelican *(Pelecanus erythrorhynchus)*	Flocks have recently become common in the Columbia Basin during all seasons foraging on fish, amphibians, and crustaceans, and roosting on islands.
[1]Peregrine falcon *(Falco peregrinus)*	Breeds and winters in eastern Washington, inhabiting open marshes, river shorelines, wide meadows, and farmlands; nests on undisturbed cliff faces; an erratic visitor to Hanford.
Sandhill crane *(Grus canadensis)*	Inhabits open prairies, grainfields, shallow lakes, marshes, and ponds; common migrant during spring and fall in Washington; some known and suspected nesting sites in eastern Washington; an occasional visitor at Hanford.
Threatened Birds	
[1]Bald eagle *(Haliaeetus leucocephalus)*	Regular winter visitor to the Columbia River, feeding on spawned-out salmon and waterfowl; they roost in the 100 Areas and nest (unsuccessfully to date) along the Hanford Reach.
Ferruginous hawk *(Buteo regalis)*	Inhabits open prairies and sagebrush plains, usually with rocky outcrops or scattered trees; known to nest in Benton and Franklin Counties, including Hanford; rarely winter in Washington, but are known to occasionally forage on small mammals, birds, and reptiles on sagebrush plains of Hanford.
Threatened Mammals	
Pygmy rabbit *(Sylvilagus idahoensis)*	Inhabits undisturbed areas of sagebrush with soils soft enough to permit burrows; once known to exist at Hanford west of the 200 Areas plateau.

[1]Indicates both state and federal designation.

Table 6. **Fish Species in the Hanford Reach of the Columbia River.**
(Page 1 of 2)

Common Name	**Scientific Name**
American Shad	*Alosa sapidissima*
Black bullhead	*Ictalurus melas*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bridgelip sucker	*Catostomus columbianus*
Brown bullhead	*Ictalurus nebulosus*
Burbot	*Lota lota*
Carp	*Cyprinus carpio*
Channel catfish	*Ictalurus punctatus*
Chinook salmon	*Oncorhynchus tshawytscha*
Chiselmouth	*Acrocheilus alutaceus*
Coho salmon	*Oncorhynchus kisutch*
Cutthroat trout	*Oncorhynchus clarki*
Dolly Varden	*Salvelinus malma*
Lake whitefish	*Coregonus clupeaformis*
Largemouth bass	*Micropterus salmoides*
Largemouth sucker	*Catostomus macrocheilus*
Leopard dace	*Rhinichthys falcatus*
Longnose dace	*Rhinichthys cataractae*
Mottled sculpin	*Cottus bairdi*
Mountain sucker	*Catostomus platyrhynchus*
Mountain whitefish	*Prosopium williamsoni*
Northern squawfish	*Ptychocheilus oregonensis*
Pacific lamprey	*Entosphenus tridentatus*
Peamouth	*Mylocheilus caurinus*

Table 6. Fish Species in the Hanford Reach of the Columbia River.
(Page 2 of 2)

Common Name	Scientific Name
Piute sculpin	*Cottus beldingi*
Prickley sculpin	*Cottus asper*
Pumpkinseed	*Lepomis gibbosus*
Rainbow trout (steelhead)	*Oncorhynchus mykiss*
Redside shiner	*Richardsonius balteatus*
Reticulate sculpin	*Cottus perplexus*
River lamprey	*Lampetra ayresi*
Sand roller	*Percopsis transmontana*
Smallmouth bass	*Micropterus dolomieui*
Sockeye salmon	*Oncorhynchus nerka*
Speckled dace	*Rhinichthys osculus*
Tench	*Tinca tinca*
Threespike stickleback	*Gasterosteus aculeatus*
Torrent sculpin	*Cottus rotheus*
Walleye	*Stizostedion vitreum vitreum*
White crappie	*Pomoxis annularis*
White sturgeon	*Acipenser transmontanus*
Yellow perch	*Perca flavescens*
Yellow bullhead	*Ictalurus natalis*

VI. SUMMARY OF SITE RISKS

6.1 Qualitative Risk Assessment

A qualitative risk assessment was performed as part of the limited field investigation, and determined the principal risk drivers at the 100-HR-3 Operable Unit and the 100-KR-4 Operable Unit. Another purpose of the qualitative risk assessment was to qualitatively evaluate human health and environmental risks to help determine if the operable units were a candidate for an interim remedial action. The qualitative risk assessment evaluated risks for a predefined set of human and environmental exposure scenarios. If the estimated risks exceeded certain thresholds, interim remedial actions were considered necessary to reduce the risks posed by the contaminants. The qualitative risk assessment is not intended to replace or be a substitute for the baseline risk assessment that will be conducted in association with determining the final action for these operable units. The qualitative risk assessment used the groundwater data from the first four rounds of the limited field investigation sampling. The data were evaluated for consistency and compliance with EPA data management guidance.

6.1.1 Human Health Risks

Human health risks were evaluated for the 100-HR-3 and 100-KR-4 Operable Units to determine whether interim remedial actions were required. The 100-HR-3 and 100-KR-4 Operable Unit Focused Feasibility Studies concluded that there were no current unacceptable human health risks from contaminants in the groundwater, primarily because exposure to groundwater contaminants is precluded by DOE site controls. The interim action is expected to provide adequate protection of human health via institutional controls, and the interim remedial action itself will not pose any unacceptable risks to human health.

6.1.2 Ecological Risks

Ecological risks were evaluated based on the exposure of biological receptors that live in or near the Columbia River to contaminants in surface water, as a result of contaminated groundwater migrating into the river. Plants and animals can also be exposed to contaminants where groundwater surfaces in springs and seeps or where plant roots reach to contaminated groundwater. Most contaminants are also transferred through the food web.

For the purposes of the qualitative risk assessment, maximum concentrations of the contaminants from near-river well samples were used to represent concentrations potentially available to aquatic receptors at the groundwater-river water interface. To estimate ecological risks, the total daily doses to animals in aquatic and riparian habitats from radiological contaminants were estimated using the CRITR2 computer code. These doses were then compared to the DOE benchmark of 1 rad/day (*DOE Order 5400.5*). For the inorganic and organic contaminants, the maximum representative groundwater concentrations from four rounds of limited field investigation sampling were compared to EPA's acute and chronic Ambient Water Quality Criteria (AWQC) for the protection of aquatic organisms. (The EPA's AWQC for hexavalent chromium are numerically equal to the State of Washington's Ambient Water Quality Standards used as an ARAR for this ROD.) If groundwater concentrations exceeded the 1 rad/day benchmark or the AWQC, an ecological risk was presumed to be present.

6.1.2.1 100-HR-3

The ecological risk analyses for 100-HR-3 indicated that none of the ecological receptors living in or near the Columbia River that were addressed in the qualitative risk assessment (plant, fish , crustacean, plant-eating duck, fish-eating duck, heron) will receive a radiological dose in excess of the 1 rad/day benchmark (table 7). The ecological risk assessment, however, identified inorganic and organic contaminants that exceeded the risk threshold (table 8). These included chromium, sulfide, and bis(2-ethylhexyl)phthalate in the 100-D/DR Area and chromium, iron, and sulfide in the 100-H Area. There are no near-river well data for the 600 Area so comparable analyses are not available (table 3), however extrapolation from surrounding groundwater data does not indicate an ecological risk. Chromium is the most toxic with respect to aquatic receptors, and is the contaminant that has been consistently observed in groundwater in the 100-HR-3 Operable Unit. Chromium (particularly the soluble mobile hexavalent form of chromium) is the most toxic of these four contaminants with respect to aquatic receptors, notably embryonic salmon. Most chromium in groundwater at the Hanford Site is hexavalent chromium, because of the original sources and prevailing geochemical conditions.

The sulfide concentration in most of the groundwater samples were at or below the 1 mg/L level of detection. One sample had a concentration of 26 mg/L, but was determined to be inconsistent with the remaining samples and eliminated from the data set in the limited field investigation. Of 107 samples analyzed for sulfides, 74 were qualified as nondetected. The remaining data were at or below the level of detection. Therefore sulfides are not considered a contaminant of concern.

Analysis of the data for bis(2-ethylhexyl)phthalate indicate that the erratic values that were occasionally obtained for this chemical result from laboratory contamination rather than a contaminant condition in the aquifer. This material, a plasticer, is a common artifact of the sampling/analysis process and is not believed to be a Hanford contaminant.

For iron, only three of the samples collected during 1993-1994 had concentrations above the chronic AWQC of 1,000 μg/L. Each sample was taken from wells constructed with carbon steel casings. After the first few rounds of sampling from these wells, concentrations dropped to several hundred μg/L. The several high concentrations of iron are believe to be an artifact of well construction material.

Table 7. Ecological Risk Summary for Radionuclide Contaminants of Potential Concern in the 100-HR-3 Operable Unit.

Organism	Total Dose to Aquatic and Riparian Receptors, Using Data From Near-River Wells (rad/day)	
	100-D Area	100-H Area
Plant	0.002	0.03
Fish	0.00005	0.002
Crustaceans	0.0001	0.003
Plant-Eating Ducks	0.01	0.06
Fish-Eating Ducks	0.0005	0.008
Heron	0.0003	0.005

Doses are calculated using the sum of all radionuclide concentrations for each area.
All doses are less than the DOE's risk benchmark of 1.0 rad/day.

Table 8. Ecological Risk Summary for Nonradionuclide Contaminants of Potential Concern in the 100-HR-3 Operable Unit.
(Page 1 of 2)

100-D Area

Analyte	Near River Wells Maximum Concentration (unfiltered, μg/L)	AWQC (unfiltered, μg/L)		Exceeds Risk Threshold
		Acute	Chronic	
Bis(2-ethylhexyl) phthalate	3			yes[a]
Barium	91.7			
Chromium (VI)	443	16	11	yes
Nitrate as N	14100	NA	NA	
Manganese	56	NA	NA	
Sulfide	1000			yes[a]
Vanadium	19.6	NA	NA	
Ammonia as N	260			

Table 8. Ecological Risk Summary for Nonradionuclide Contaminants of Potential Concern in the 100-HR-3 Operable Unit. (Page 2 of 2)

100-H Area

Analyte	Near River Wells Maximum Concentration (unfiltered, in $\mu g/L$)	AWQC (unfiltered, $\mu g/L$)		Exceeds Risk Threshold
		Acute	Chronic	
Barium	100			
Chromium (VI)	490	16	11	yes
Flouride	80			
Iron	1500	1000		yes[a]
Nitrate as N	32000			
Sulfide	1000			yes[a]
Ammonia as N	29			
Chloroform	31	28900	1240	

NA - No data available
AWQC - Ambient Water Quality Criteria for Protection of Aquatic Life
(B) Concentration below the contract required detection limit but above the instrument detection limit.
(J) Estimated value.
[a] Appears to be an artifact of well construction, sampling, or analysis.
Contaminants of potential concern are contaminants that were detected at concentrations above sitewide background.

6.1.2.2 100-KR-4

The ecological risk analyses for 100-KR-4 indicated that one of the ecological receptors (Table 9, fish-eating ducks) living in or near the Columbia River that were addressed in the qualitative risk assessment will receive a radiological dose in excess of the 1 rad/day benchmark (DOE Order 5400.5). The dose was primarily due to carbon-14. Carbon-14 appears in three 100-K Area wells at elevated concentrations. None of these wells are located within the chromium plume that is the target of the interim action. The source of the elevated carbon-14 appears to be the french drains that received condensate from the inert gas used in 100-K West and 100-K East reactor operations. These contaminant sources will be addressed in the ROD for the 100-KR-2 Operable Unit. The ecological assessment also identified inorganic contaminants that exceeded the AWQC (Table 10). These included cadmium, chromium, iron, lead, silver and zinc.

Only two samples from one well, 199-K-18, had cadmium concentrations greater than the concentrations associated with the lowest observed effect levels reported in the literature. Several of the samples exceeded EPA's AWQC. These data are believed to be artifacts of the well construction.

One of 25 samples collected from near-river wells during the March 1993 to January 1994 period exceeded EPA's AWQC for iron of 1000 μg/L. The rest of the detectable concentrations were well below this level with many nondetects.

Lead concentrations were all below 5.9 μg/L and appear to represent a background level more than a contaminant plume. Fifteen out of a total 20 samples were below the detection limit. The five detectable concentrations ranged from 3.1 to 5.9 μg/L.

Only one out of 26 samples had a detectable concentration of silver during the January 1993 through January 1994 period.

Zinc is present at a level exceeding the EPA AWQC of 110 μg/L in well 199-K-22 (figure 5). This well is located within the chromium plume that is the target of this interim action. Elevated concentration of zinc in this well are believed to result from a galvanized screen (zinc plated) that was installed in this well, and thus is not representative of a zinc plume.

6.1.3 Risk Summary for 100-HR-3 / 100-KR-4

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment. Groundwater contaminated with chromium is identified in the three reactor areas at concentrations in excess of ecological-based risk thresholds. This groundwater discharges to the Columbia River primarily via upwelling through the river bottom, an environment known to be critical to sensitive ecological receptors such as embryonic salmon. In addition, concentrations of several contaminants exist in groundwater at these operable units that exceed human health levels.

Table 9. Ecological Risk Summary for Radiological Contaminants of Potential Concern in the 100-KR-4 Operable Unit.

Receptor	Estimated Total Dose (rad/day)	Major Contributor
Plant	0.19	Carbon-14
Fish	0.37	Carbon-14
Crustacean	0.37	Carbon-14
Plant-eating Duck	0.33	Carbon-14
Fish-eating Duck	1.1[a]	Carbon-14
Heron	0.70	Carbon-14

[a]Estimated total dose exceeds DOE benchmark of 1 rad/day

Table 10. Ecological Risk Summary for Nonradionuclide Contaminants of Potential Concern in the 100-KR-4 Operable Unit.

Analyte	Near River Wells Maximum Concentration (unfiltered, in $\mu g/L$)	AWQC (unfiltered, $\mu g/L$)		Exceeds Risk Threshold
		Acute	Chronic	
Aluminum	72.1(B)			
Cadmium	2.2(B)	3.9	1.1	yes[b]
Chloride (mg/L)	21.6	860	230	
Chromium (VI)	261	16	11	yes
Iron	1230	1000		yes[b]
Lead	5.8(J)	82	3.2	yes[b]
Manganese	69.6			
Nickel	9.9	1400	160	
Nitrate/Nitrite (mg/L)	26			
Silver	5.2(B)	4.1	0.12	yes[b]
Vanadium	19.1(B)			
Zinc	461(B)	120[a]	110[a]	yes[b]
Trichloroethene	19	45000	21900	
Chloroform	17	28900	1240	

a Actual value is hardness dependent. Approximate value using typical Columbia River hardness of 100 mg/l hardness is provided for comparison purposes.
b Appears to be an artifact of well construction, sampling, or analysis.
NA No data available
AWQC Ambient Water Quality Criteria for Protection of Aquatic Life
(B) Concentration below the contract required detection limit but above the instrument detection limit.
(J) Estimated value.
Contaminants of potential concern are contaminants that were detected at concentrations above sitewide background.

VII. REMEDIAL ACTION OBJECTIVES

Remedial action objectives to protect human health and the environment include the following 3 components:

* Protection of aquatic receptors in the river bottom substrate from contaminants in groundwater entering the Columbia River.
* Protection of human health by preventing exposure to contaminants in the groundwater.
* Provide information that will lead to the final remedy.

These three components are detailed below.

PROTECTION OF AQUATIC RECEPTORS

The first remedial action objective for the 100-HR-3 and 100-KR-4 Operable Units is to prevent the discharge of hexavalent chromium to the Columbia River substrate at concentrations exceeding those that are considered protective of aquatic life in the River and riverbed sediments. Prioritization of areas to be addressed by the remedial action will be based on suitable salmon habitat. The aquatic receptor exposure point of concern is within the river substrate at depths up to 18 inches (46 centimeters), where embryonic salmon and fry could be present during parts of the year. The relevant standard is the State of Washington's chronic Ambient Water Quality Standard for Protection of Freshwater Aquatic Life for hexavalent chromium of 11 parts per billion (WAC 173-201A-040). Monitoring will be performed to assess the effectiveness of the remedial action in meeting the Ambient Water Quality Standard. Remedial actions should improve water quality in the aquifer by removing contaminants, reducing mobility or toxicity.

Protection of Human Health From Exposure to Groundwater

A second remedial action objective for these operable units is to continue to protect the public such that there is no exposure to contaminants above health based levels. This objective can be achieved by preventing exposure to contaminated groundwater or reduction of contaminants to health based levels as a result of actions taken to protect ecological receptors.

Provide Information That Will Lead to the Final Remedy

Additional information will be obtained during the interim action prior to the development and implementation of a final action. Effectiveness of the interim action will be evaluated based on site-specific data. This evaluation should include: treatment cost, efficiency, evaluation of other technologies, hydraulic impacts, and effectiveness of contaminant removal from the aquifer.

VIII. DESCRIPTION OF ALTERNATIVES

The 100 Area Feasibility Study, Phases 1 and 2 provided a list of six generic groundwater alternatives that could be applied to the groundwater operable units in the 100 Areas. Of the six alternatives, only five were applicable to groundwater remediation at the 100-HR-3 and 100-KR-4 Operable Units:

- Alternative 1: No Action
- Alternative 2: Institutional Control/Continued Current Actions
- Alternative 3: Containment
- Alternative 4: Removal/Reverse Osmosis Treatment/Disposal
- Alternative 5: Removal/Ion Exchange Treatment/ Disposal.

The treatment of groundwater contaminants *in situ* was evaluated and dropped from the 100 Area Feasibility Study, Phases 1 and 2, as an appropriate alternative for the 100-HR-3 and 100-KR-4 Operable Units because insufficient information was available on in situ treatment methods. However, more recently DOE has conducted tests of reduction/oxidation in situ treatment technology and will consider this technology for implementation of future remedial actions at the 100-HR-3 and 100-KR-4 Operable Units.

8.1 Common Elements.

All five alternatives, except the no action alternative, evaluated for the 100-HR-3 and 100-KR-4 Operable Units include controls to prevent human access to groundwater and to require that groundwater concentrations will be tested. In addition to continued access restrictions, the present network of groundwater monitoring wells will be maintained, and samples will be collected to monitor chromium concentrations in groundwater. Monitoring will also aid in determining when these controls are no longer necessary. To provide a common basis for comparative purposes, costs, as shown below for each alternative were developed for the first 5-year period. A 5 percent annual discount rate was applied to calculate present worth. This 5-year cost-planning period is not a basis for cessation of the pump-and-treat action at the end of that period. As required by CERCLA, this remedy will be reviewed at least as often as every 5 years.

8.2 Remedial Alternatives Evaluated

Alternative 1: No Action - Evaluation of this alternative is required by CERCLA to compare the no action alternative with the different action alternatives, and to consider taking no action if appropriate. Under the no action alternative, no CERCLA groundwater monitoring would be required. Although the DOE would retain control of the site throughout the interim period, no institutional controls would be implemented specifically for the no action alternative. Additional monitoring and restrictions would not be implemented, and contamination in the groundwater would flush into the Columbia River.

100-HR-3	Capitol Cost:	$0
	Operation and Maintenance Cost (5-year period):	$0
	Present Worth (5-year period):	$0
	Estimated Time to Implement:	0 Months
100-KR-4	Capitol Cost:	$0
	Operation and Maintenance Cost (5-year period):	$0
	Present Worth (5-year period):	$0
	Estimated Time to Implement:	0 Months

Alternative 2: Institutional Controls/Continued Current Actions - This alternative involves commitment to continued groundwater monitoring and institutional controls. Institutional controls would include, but may not be limited to, access and land-use restrictions, and site security. Groundwater monitoring would be used to continually evaluate the effectiveness of this interim action, and to support decisions to continue the action or implement other interim remedial actions (including the no action alternative). This alternative would also utilize the data from ongoing studies to evaluate this interim action, complete the groundwater conceptual model, and generate additional technology performance data.

100-HR-3	Capital Cost:	$0
	Operation and Maintenance Cost (5-year period):	$1,200,000
	Present Worth (5-year period):	$1,000,000
	Estimated Time to Implement:	0 Months
100-KR-4	Capital Cost:	$0
	Operation and Maintenance Cost (5-year period):	$600,000
	Present Worth (5-year period):	$500,000
	Estimated Time to Implement:	0 Months

Alternative 3: Containment - For this alternative, cutoff walls would be installed next to the Columbia River to isolate the existing groundwater chromium plume. A cutoff wall is a subsurface vertical barrier designed to prevent the migration of contaminants, divert uncontaminated groundwater around contaminant plumes, or completely surround contaminant plumes. A network of extraction and injection wells, termed hydraulic control, would be installed to intercept and control the contaminated groundwater plume and enhance the effectiveness of the cutoff wall. The objective of the containment alternative would be to eliminate receptor pathways by preventing migration of contaminated groundwater to environmental receptors, such as those in the Columbia River.

100-HR-3	Capital Cost:	$12,200,000
	Operation and Maintenance Cost (5-year period):	$15,300,000
	Present Worth (5-year period):	$25,400,000
	Estimated Time to Implement:	15 Months

100-KR-4	Capital Cost:	$32,200,000
	Operation and Maintenance Cost (5-year period):	$32,200,000
	Present Worth (5-year period):	$60,100,000
	Estimated Time to Implement:	15 Months

Alternative 4: Removal/Reverse Osmosis Treatment/ Disposal - Groundwater would be removed through a series of extraction wells placed within the groundwater plume. Reverse osmosis would be used to remove hexavalent chromium to the maximum extent practicable to speed the remedy, and in no event shall the effluent concentration exceed 50 μg/L. Reverse osmosis uses a membrane that allows water to pass, but will not pass chromium and most co-contaminants. Contaminants removed from the groundwater would be treated as needed to meet requirements for transportation to and disposal in an appropriate on-site facility such as the Environmental Restoration Disposal Facility. Treated groundwater would be reinjected to the aquifer. The objectives of this option would be to prevent migration of groundwater containing chromium above the AWQC into the Columbia River, to prevent migration outside the operable unit, and to minimize source-to-receptor pathways by removal, treatment, and disposal of groundwater contaminants. Costs below are based on treating 8.6×10^8 gallons at 100-HR-3 and 5.8×10^8 gallons at 100-KR-4.

100-HR-3	Capital Cost:	$7,400,000
	Operation and Maintenance Cost (5-year period):	$24,600,000
	Present Worth (5-year period):	$28,800,000
	Estimated Time to Implement:	15 Months
100-KR-4	Capital Cost:	$4,700,000
	Operation and Maintenance Cost (5-year period):	$13,800,000
	Present Worth (5-year period):	$16,700,000
	Estimated Time to Implement:	15 Months

Alternative 5: Removal/Ion Exchange Treatment/ Disposal - Groundwater will be removed through a series of extraction wells placed within the groundwater plume. Hexavalent chromium will be removed by ion exchange treatment to the maximum extent practicable to speed the remedy, and in no event shall the effluent concentration exceed 50 μ/L. The ion exchange media, when exhausted, would be replaced with new media. Exhausted media will be disposed at the Environmental Restoration Disposal Facility in the Hanford 200 Area. The objectives of this alternative are the same as for Alternative 4.

100-HR-3	Capital Cost:	$6,600,000
	Operation and Maintenance Cost (5-year period):	$13,700,000
	Present Worth (5-year period):	$18,600,000
	Estimated Time to Implement:	15 Months
100-KR-4	Capital Cost:	$4,200,000
	Operation and Maintenance Cost (5-year period):	$8,100,000
	Present Worth (5-year period):	$11,200,000
	Estimated Time to Implement:	15 Months

IX. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

9.1 CERCLA Nine Criteria

This section summarizes the relative performance of each of the alternatives with respect to the nine criteria identified in the NCP. These criteria fall into three categories: The first two (Overall Protection of Human Health and the Environment and Compliance with ARARs) are considered threshold criteria and must be met. The next five are considered balancing criteria and are used to compare technical and cost aspects of alternatives. The final two criteria (State and Community Acceptance) are considered modifying criteria. Modifications to remedial actions may be made based upon state and local comments and concerns. These were evaluated after all public comments were received.

A description of the nine evaluation criteria contained in the NCP, and a brief analysis of each alternative against the criteria is presented in the box below. The five alternatives are evaluated against these criteria to select the remedy. Only criteria pertinent to the selection of an interim action have been addressed in detail.

EXPLANATION OF CERCLA EVALUATION CRITERIA

Threshold Criteria:

1. *Overall Protection of Human Health and the Environment - How well does the alternative protect human health and the environment, both during and after construction?*

2. *Compliance with Applicable or Relevant and Appropriate Requirements - Does the alternative meet all federal and state applicable or relevant and appropriate requirements (ARARs)?*

Balancing Criteria:

3. *Long-Term Effectiveness and Permanence - How well does the alternative protect human health and the environment after completion of cleanup? What, if any, risks will remain at the site?*

4. *Reduction of Toxicity, Mobility, or Volume Through Treatment - Does the alternative effectively treat the contamination to significantly reduce the toxicity, mobility, and volume of the hazardous substances?*

5. *Short-Term Effectiveness - Are there potential adverse effects to either human health or the environment during construction or implementation of the alternative. How quickly does the alternative reach the cleanup goals?*

6. *Implementability - Is the alternative both technically and administratively feasible? Has the technology been used successfully on other similar sites?*

7. *Cost - What are the estimated costs of the alternative?*

Modifying Criteria:

8. *State Acceptance - What are the state's comments or concerns about the alternatives considered and about EPA's preferred alternative? Does the state support or oppose the preferred alternative?*

9. *Community Acceptance - What are the community's comments or concerns about the preferred alternative? Does the community generally support or oppose the preferred alternative?*

9.1.1 Overall Protection of Human Health and the Environment - All remedial alternatives except the No Action Alternative would protect human health because institutional controls limit direct exposure to groundwater. Alternative 3 (Containment), 4 (Reverse Osmosis), and 5 (Ion Exchange) would provide the best protection of the environment by reducing chromium concentrations and exposure of ecological receptors to chromium.

9.1.2 Compliance with Applicable or Relevant and Appropriate Requirements - The ARARs identified for the five alternatives include the State of Washington's Chronic Ambient Water Quality Standard for Protection of Freshwater Aquatic Life for hexavalent chromium (WAC 173-201A-040); state Underground Injection Standards (WAC 173-218) for chromium, for the injection of treated groundwater; and state dangerous waste management standards (WAC 173-303) for management and disposal of those treatment resins determined to be dangerous wastes.

Alternative 1 (No Action) would not invoke ARARs that would need to be satisfied. Alternative 1 (No Action) and Alternative 2 (Institutional Controls/Continued Current Actions) will not meet the water quality standards in the Columbia River, as these alternatives would allow hexavalent chromium to continue to exist in the river at levels above the ambient water quality standards.

Alternatives 3 (Containment), 4 (Reverse Osmosis), and 5 (Ion Exchange) would be designed with the intent of achieving ambient water quality standards for hexavalent chromium in the river substrate either by retarding (alternative 3) the flow of groundwater or by removing (alternatives 4 and 5) hexavalent chromium in groundwater before it discharges to the river.

The interim remedial action selected, is protective of human health and the environment, and complies with Federal and State applicable or relevant and appropriate requirements directly associated with this action (by preventing human exposure to contaminated groundwater, and preventing chromium exceedances of the AWQC in the Columbia River substrate). Ambient water quality standards, and state injection standards for contaminants other than chromium may not be met. Specifically, discharge of strontium-90, tritium, and nitrate are anticipated to be above standards. The interim remedial action addresses chromium and is part of a final remedial action that will satisfy ARAR requirements when completed.

9.1.3 Long-Term Effectiveness and Permanence - The ion exchange treatment alternative will be the most effective and permanent in reducing long-term risk, including risk of exposure to ecological receptors, and the system could be expanded. The reverse osmosis treatment alternative would be more difficult to expand should increased groundwater recovery rates be required. The containment alternative would provide protection of the river by limiting the migration of contaminants into the river, but there would be no reduction in the mass of contaminants in the aquifer, except by natural processes. Under the containment alternative, contaminants would eventually migrate past a barrier wall and into the river. Alternatives 1 (No Action) and 2 (Institutional Controls/ Continued Current Actions) do not provide significant long-term effectiveness.

9.1.4 Reduction of Toxicity, Mobility, or Volume Through Treatment - Through treatment, the ion exchange and reverse osmosis treatment alternatives would provide the most reduction in toxicity, mobility, and volume of chromium in the groundwater. The remaining alternatives contain no treatment.

9.1.5 Short-Term Effectiveness - Of the three alternatives judged most likely to meet the remedial action goal (Alternatives 3, 4, and 5), short-term effectiveness is met by reducing chromium exposure to ecological receptors. Alternative 3 (Containment) would causes the most short-term impacts to the riparian and terrestrial habitat and their inhabitants, as well as to cultural resources. Alternatives 4 and 5 (Reverse Osmosis and Ion Exchange) would cause lesser short-term impacts. These impacts would be mitigated, to the extent practicable, during construction. The Alternatives 1 (No Action) and 2 (Institutional Controls/Continued Current Actions) will not be effective in the short term. Alternative 4 (Reverse Osmosis) generates the greatest amount of sludge and thus the greatest sludge-disposal impact. Alternative 5 (Ion Exchange) generates less sludge volume whereas Alternatives 1, 2, and 3 generate no sludge and hence have no secondary disposal impacts.

9.1.6 Implementability - Alternative 2 (Institutional Controls/Continued Current Actions) would require administrative actions to implement restrictions and current monitoring. The technology for Alternative 5 (Ion Exchange) is well established and easily implemented. Alternative 4 (Reverse Osmosis) is somewhat more difficult to implement due to maintenance necessary to keep the membrane system functioning and the large capacity treatment system needed for the secondary waste slurry. Alternative 3 (Containment) using vertical barrier technology is difficult to implement because of geologic conditions such as large boulders. The hydraulic barrier technology is relatively easy to implement.

Implementation of any of the remedial alternatives would require close coordination with state and federal resource agencies, Native American Tribes, and Natural Resource Trustees to avoid or minimize further impacts to ecological receptors while conducting remedial activities.

9.1.7 Cost - Of the three alternatives judged most likely to meet the interim remedial action goal (Alternatives 3, 4, and 5), the lowest present worth costs are for Alternative 5 (Ion Exchange): $29,800,000, and Alternative 4 (Reverse Osmosis): $45,500,000. The highest present worth cost is for the Alternative 3 (Containment): $85,500,000. Alternatives 1 (No Action) and 2 (Institutional Controls/Continued Current Actions) would not require capital investment. The capital, operation and maintenance, and present worth costs of each alternative are presented in the alternative descriptions above. Costs presented are preliminary, and are presented for comparison purposes only. A definitive cost estimate for the selected remedy will be prepared as part of remedial design.

9.1.8 State Acceptance - The State of Washington concurs with the selected alternative.

9.1.9 Community Acceptance - Appendix A of this ROD is a responsiveness summary to comments received during the 45 day public comment. Written comments supported taking a cleanup action at these operable units. Generally the comments received during the public meeting in Hood River (see Section III), although general in nature, were supportive of pump-and-treat actions to prevent the spread of groundwater contamination and to protect the Columbia River.

9.2 EVALUATION OF POTENTIAL ENVIRONMENTAL IMPACTS

The environmental consequences of implementing the remedial alternatives, including potential short-term direct and indirect impacts, have been evaluated in Section 6.0, Detailed Analysis of Alternatives, in 100-HR-3 Operable Unit Focused Feasibility Study and 100-KR-4 Operable Unit Focused Feasibility Study. Impacts are expected to be limited to potential exposure of remediation workers to hazardous or radioactive substances, short-term indirect impact to wildlife from construction noise, and disturbance of the land area designated for wells, equipment, and facilities. Removal of groundwater contamination is expected to improve rather than degrade ecological conditions in the river. The cumulative impact of implementing reasonable foreseeable remedial actions in 100 Area operable units is expected to generally improve ecological conditions in the 100 Areas in the long term.

Ecological review of the operable units indicates that the sites to be impacted by the interim remedial action are located within areas previously disturbed by pre-Hanford Site agricultural activities and by previous reactor operations at the Hanford Site. Because of the previous disturbance, ecological or cultural resources are not expected to be significantly impacted by the interim remedial action. However, Cultural and Natural Resource Reviews will be conducted before siting each well, pipeline, or treatment facility to determine the potential impacts associated with specific actions. Mitigation measures will include actions to minimize dust, use of protective equipment to minimize worker exposures, seasonal scheduling of site work to minimize disturbance to wildlife, archeological monitoring and/or data recovery, as appropriate, and revegetation of the site following interim action.

X. SELECTED REMEDY

The selected remedy shall satisfy ARARs and meet the remedial action objectives set forth in Section VII and includes the following:

- **Groundwater Extraction**
  Groundwater will be extracted from wells primarily located along the river in each of the three reactor areas. Extraction wells should be located at a sufficient distance inland from the river to minimize withdrawal of river water. Extraction wells shall be located such that the plume is captured to meet the remedial action objectives. Based on preliminary modeling accomplished for the operable unit focused feasibility studies, the following extraction well design was estimated as sufficient to capture the chromium plume to meet the chromium remedial action objectives:

  > 100-K Area: Eleven extraction wells spaced approximately 240 m (786 ft) apart with a composite withdrawal rate of 220 gpm.
  > 100-H Area: Nine extraction wells spaced approximately 160 m (515 ft) apart with a composite withdrawal rate of 225 gpm.
  > 100-D Area: Ten extraction wells spaced approximately 160 m (515 ft) apart with a composite withdrawal rate of 100 gpm.

  During remedial design, estimates will be improved based on the incorporation of the results of ongoing river pore water sampling and shoreline drive point sampling, recent groundwater sampling data, and other pertinent data collected since the completion of the focused feasibility study. The groundwater extraction system shall be designed in accordance with the Remedial Design Report/Remedial Action Work Plan (RDR/RAWP) as approved by EPA and Ecology.

- **Groundwater Treatment and Discharge Standards - Hexavalent Chromium**
  100-D, 100-H, and 100-K Areas: The groundwater treatment systems will reduce the effluent chromium concentrations to the maximum extent practicable. However, groundwater above 50 μg/L chromium will not be discharged. The average chromium concentrations in the effluent are expected to be below this standard. This will be performed using ion exchange resins such as a weak base anionic resin with a high selectivity toward chromate anions (hexavalent chromium).

- **Groundwater Treatment - Other Contaminants**
  Because this interim action is designed to reduce levels of hexavalent chromium in the groundwater and the river substrate, there is a potential for other groundwater co-contaminants to be present in the reinjected effluent at concentrations above the drinking water standards set for those contaminants. Potential co-contaminants include nitrate, strontium-90, tritium, uranium, and technicium-99. The ion exchange system required to remove chromium will also reduce concentrations of other anionic contaminants such as nitrate, technicium-99, and uranium-238. Strontium-90 exists in groundwater as a cation and is not expected to be removed in the ion exchange system.

Tritium is also not expected to be removed by the treatment system. In addition to chromium at both operable units, other potential co-contaminants include:

> 100-HR-3: nitrate, strontium-90, tritium, uranium, and technetium-99.
> 100-KR-4: tritium and strontium-90.

These other co-contaminants do not exceed the ecological risk criteria, and institutional controls (detailed elsewhere) limit human exposure.

- **Groundwater Reinjection**
  After treatment, water will be reinjected into the upper aquifer, using injection wells located upgradient of the existing chromium plume in the 100-HR-3 and 100-KR-4 Operable Units respectively. Based on preliminary modeling accomplished for the operable unit Focused Feasibility Studies, the number of wells needed to accomplish this was estimated to be:

  > 100-D Area: Five injection wells.
  > 100-H Area: Three injection wells.
  > 100-K Area: Two injection wells.

  During the remedial design process, more precise estimates are expected to be developed based on the collection and incorporation of well and site-specific data. The groundwater treatment and reinjection system shall be designed in accordance with the RDR/RAWP as approved by EPA and Ecology.

- **Compliance Monitoring - River Protection**
  The data analysis and evaluation procedures used to evaluate compliance with cleanup levels shall be defined in a compliance monitoring plan as part of the RDR/RAWP and prepared in accordance with WAC 173-340-720(8) and/or as approved by EPA and Ecology.

  The aquatic receptor exposure point of concern is within the river substrate at depths up to 18 inches (46 centimeters), where embryonic salmon and fry could be present during parts of the year. Since it is impractical to routinely monitor the river substrate, groundwater will be monitored at near-river on-shore locations above the common high river mark. Monitoring shall be conducted at sufficient locations to evaluate the performance of the remedial action. The siting and design of the compliance monitoring system shall be in accordance with the RDR/RAWP as approved by EPA and Ecology. To account for dilution within the aquifer between the monitoring location on-shore and the aquatic receptor exposure point of concern within the river substrate, a preliminary dilution factor of 1:1 has been selected based on the available data (i.e., 22 μg/L hexavalent chromium in on-shore near-river well points is considered equivalent to 11 μg/L hexavalent chromium in the river substrate). It will take a period of time for the extraction system to have an effect on groundwater quality adjacent to the Columbia River. Concentrations in excess of 22 $\mu g/L$ may be observed in the compliance wells during the early stages of operation.

Groundwater sampling will be conducted when dilution by river water at the compliance monitoring points is minimal. The details of the groundwater quality monitoring program will be described in the RDR/RAWP. Chromium compliance monitoring will be conducted at multiple depth intervals. Baseline sampling will be conducted prior to the start of the interim action.

Sampling will be conducted monthly for at least three months following start-up of the extraction system. Subsequently, there may be substantial reductions in frequency, number of stations, and depths sampled, if demonstrated to be appropriate, and approved by EPA and Ecology. A network of piezometers (or comparable technique) will be installed and monitored such that the capture zone around the extraction wells can be estimated.

In the event of special conditions such as an unusual flood event or prolonged down-time of the pump-and-treat system, extra monitoring, at the direction of EPA or Ecology shall be conducted.

The analyte list will be defined during remedial design; it shall include:

- Hexavalent chromium (or total chromium assumed to be hexavalent). The method detection limit and quantitation limit of the selected test method shall be sufficiently low to allow comparison with the remedial action goals.
- Conductivity or comparable measurements adequate to indicate ratio of river-derived versus groundwater-derived water.
- On an infrequent basis, likely co-contaminants will be monitored as part of on-going Tri-Party Agreement activities to assess protectiveness of human health and the environment.

Compliance monitoring will include analysis of results in a timely manner to support modifications to the treatment system in order to meet the remedial action objectives. Significant system modifications as identified in the RDR/RAWP are subject to EPA and Ecology approval.

- **Compliance Monitoring - Effluent for Reinjection**
  The data analysis and evaluation procedures used to evaluate compliance with cleanup levels shall be defined in the RDR/RAWP and prepared using with WAC 173-340-720(8) and approved by EPA and Ecology.

- **Construction Requirements**
  Construction requirements shall be scoped as part of the RDR/RAWP with guidance provided by and as approved by EPA and Ecology. This Work Plan shall include at least the following elements:

- Construction is expected to comply with appropriate worker safety requirements.
- In coordination with wildlife and other resource management agencies, activities should avoid or minimize disruption to local wildlife and other natural resources to the extent practicable.
- Design should provide for flexibility following startup to accommodate changes in plume characteristics, or different understandings of actual or perceived responses of the aquifer/plume to the pump-and-treat system. When the actual response of the aquifer is known, the pump and treat systems may be altered as needed, and approved by EPA and Ecology to meet the remedial action objectives.
- For areas that are disturbed during construction and operation, it is expected that the land will be revegetated following construction in those areas that are not needed for operation and maintenance of the treatment system and where the land is also not expected to be re-disturbed within the next few years by other site activities. Following completion of the interim action, it is expected that rectification of the habitat affected by this activity will be conducted and coordinated with activities in the source operable units (100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-KR-1, and 100-KR-2).
- To the extent practicable, facilities are expected to be designed and located in a manner that minimizes interference with and interference by remedial actions for the source waste sites.
- Sites with cultural resource significance should be avoided during remedial activities if avoidance is possible. Where avoidance is not possible, a data recovery/mitigation plan must be prepared in consultation with the affected resource trustee and carried out for each site impacted by remedial activities.

- **Schedule**

  Draft A of the RDR/RAWP is due to EPA and Ecology 120 calendar days after the ROD is signed.

  Phase 1: Two pump-and-treat systems designed in accordance with this ROD in two of the three reactor areas are to be operating as per the RDR/RAWP within 15 months of this ROD. Operating is defined as continuous removal and treatment of water at rates defined in the RDR/RAWP. Some limited testing needed to optimize the system is expected.
  Phase 2: The third pump-and-treat system in the third reactor area shall be operating as per the RDR/RAWP within 18 months of this ROD.

  The RDR/RAWP will establish a schedule including Tri-Party Agreement milestones for this interim remedial action. This Work Plan including the schedule is subject to EPA and Ecology approval.

- **Resin Disposal**

Waste generated during the remedial action, principally exhausted resins, will be disposed of at the Environmental Restoration Disposal Facility (ERDF) or at other on-site facilities as appropriate. Resins will be stabilized prior to disposal such that:

- The Chromium concentration in leachate generated using the Toxicity Characteristic Leachate Procedure (TCLP) is less than 5.0 mg/l
- ERDF waste acceptance criteria are met for disposal at ERDF.

In the event that some materials cannot be disposed to ERDF or other on-site facilities, and require disposal at an off-site facility, such a facility must be in compliance with EPA's Offsite Rule (40 CFR 300.440) concerning off-site disposal of wastes. If during the design or conduct of the remedial action it is determined that regeneration of resins is appropriate, that option may be implemented with any waste disposed as described for resins in this paragraph.

- **Human Access Institutional Controls**
  Institutional controls are required to prevent human exposure to groundwater. The DOE is responsible for establishing and maintaining land use and access restrictions until MCLs and risk-based criteria are met or the final remedy is selected. Institutional controls include placing written notification of the remedial action in the facility land use master plan. The DOE will prohibit any activities that would interfere with the remedial activity without EPA and Ecology concurrence. In addition, measures necessary to ensure the continuation of these restrictions will be taken in the event of any transfer or lease of the property before a final remedy is selected. A copy of the notification will be given to any prospective purchaser/transferee before any transfer or lease. The DOE will provide EPA and Ecology with written verification that these restrictions have been put in place.

- **Up-time requirements**
  Operating pump-and-treat systems as described in this ROD and the subsequent RDR/RAWP will achieve substantial treatment for this interim action. The extraction and treatment system shall be designed to run on an essentially continuous basis such that routine procedures such as resin changes and mechanical maintenance can be conducted with minimal impact to system operations.

  The system should be winterized such that winter weather or preparation for winter weather does not cause extended shut-down of the system and compromise the remedial action objectives. The system shall be designed such that if one or several of the wells are down (such as due to a mechanical problem, or a well pump needs to be replaced), the rest of the system can continue operating. In the event of a partial or total system shutdown EPA or Ecology may impose additional near-river compliance sampling requirements. EPA and Ecology may also authorize short-term intentional shutdowns for the purposes of observing aquifer response or for other purposes as deemed appropriate. The provisions of this paragraph do not apply at the conclusion of the interim action.

- **Investigation-Derived Waste**
  Remedial investigation at 100-HR-3 and 100-KR-4 generated investigation-derived waste consisting of soil and slurries from monitoring well installation, and purge water generated during development and monitoring of the wells. This waste is stored in the respective reactor areas in drums. Soil will be disposed to ERDF, as will slurries following dewatering in accordance with ERDF waste acceptance criteria. Water may be processed via the ion exchange treatment system installed for groundwater under this ROD.

- **Impacts to RCRA Monitoring**
  Two RCRA treatment, storage, and disposal (TSD) units, 100-D Pond and the 183-H Solar Evaporation Basins, are located within the boundaries of the 100 HR-3 Operable Unit. The 183-H basins are anticipated to be remediated and closed under RCRA, and the 100-D Pond is currently an inactive unit. The implementation of the remedial actions under this Interim Action ROD are believed likely to impact the current RCRA groundwater sampling program around both of these facilities. For any RCRA unit whose monitoring compliance program is impacted, Ecology may approve modifications to the monitoring program as appropriate. Potential alternative compliance actions include monitoring other existing wells (including remediation wells) for appropriate RCRA constituents during the period when the groundwater is affected by the remedial action.

- **Operational Requirements**
  The pump and treat portion of the interim remedial action will continue until the selection of a final action or it is demonstrated to EPA's and Ecology's satisfaction that termination (or intermittent operation) is appropriate because: (A) sampling indicates that hexavalent chromium is below the compliance value, and site data indicate it will remain below the compliance value; or (B) based on an evaluation of the following criteria:

  - The effectiveness of the treatment technology does not justify further operation.
  - An alternate treatment technique, such as in situ chemical reduction or other improved treatment technique is evaluated and proves to be more effective, and/or less costly, and is consistent with the remedial action objectives.

- **Wetlands and Flood Plains**
  The interim action will be implemented such that to the extent practicable disturbance to wetlands will be avoided and system components except monitoring points will be located away from wetlands. System components will be located such that they will not increase deleterious effects of flooding.

- **Protectiveness**
  The interim action is expected to provide adequate protection of human health and ecological receptors in the Columbia River until implementation of the final remedy for the 100-HR-3 and 100-KR-4 groundwater operable units, or until such time that the

DOE demonstrates to Ecology and the EPA that no further interim action is required. Contaminated soil overlying these operable units are or will be addressed in separate remedial actions.

- **Disposal to ERDF and Lead Regulatory Agency**
  The 100-HR-3 Operable Unit was initially designated as a *Resource Conservation and Recovery Act* (RCRA) Past Practice unit. The Tri-Parties have decided to redesignate this operable unit as a CERCLA Past Practice unit in order to facilitate the disposal of contaminated materials at the CERCLA Environmental Restoration Disposal Facility (ERDF). Section 5.4 of the Hanford Federal Facility Agreement and Consent Order signed by the DOE, EPA, and Ecology (and hence termed the Tri-Party Agreement) describes the process that was followed to initially designate operable units as RCRA Past Practice or CERCLA Past Practice, and indicates that the remedial actions selected for operable units under either designation would be comprehensive to satisfy the technical requirements of both statutory authorities. Ecology will remain the lead regulatory agency for 100-HR-3 following redesignation.

XI. STATUTORY DETERMINATIONS

Under CERCLA Section 121, selected remedies must be protective of human health and the environment, comply with ARARs, be cost effective, and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practical. In addition, CERCLA includes a preference for remedies that employ treatment that significantly and permanently reduces the volume, toxicity, or mobility of hazardous substances as their principal element. This section discusses how the selected remedy meets these statutory requirements.

The selected remedy provides the best balance of tradeoffs among the alternatives with respect to evaluation criteria that are used to evaluate remedies under CERCLA. The selected remedy will protect human health with institutional controls and protect the environment by reducing the discharge of contaminants to the river. It will comply with ARARs for hexavalent chromium directly associated with this action, is cost effective, and will utilize permanent solutions to the maximum extent practicable. The selected alternative satisfies the CERCLA preference for treatment as a principal element.

11.1 Protection of Human Health and the Environment

Site institutional controls will continue during the interim remedial action period. These controls limit human access to the groundwater and thereby limit human exposure to acceptable risk levels. The ecological risk resulting from the groundwater flow into the river is addressed by the pump-and-treat component of the action identified in this ROD. The pump-and-treat will reduce the concentration of chromium to Ambient Water Quality Standards within the river bottom substrate. Implementation of this remedial action will not pose unacceptable short-term risks toward site workers that cannot be mitigated through acceptable remediation practices.

11.2 Compliance with ARARs

The selected remedy will comply with the federal and state ARARs identified below. This interim remedial action addresses chromium in the groundwater (by preventing human exposure to contaminated groundwater, and preventing chromium exceedances of AWQC in the Columbia River substrate) and is only part of a final remedial action that will satisfy other ARAR requirements when completed. The ARARs identified for the action identified in this ROD are the following:

11.2.1 Chemical-Specific ARARs

- Underground Injection Standards (WAC 173-218) and Underground Injection Control Program (40 CFR 144, Subpart B) for chromium are applicable to reinjection of treated groundwater.

- *Clean Water Act*, Ambient Water Quality Criteria for Protection of Aquatic Life (50 FR 30788, 40 CFR 131) for chromium are relevant and appropriate for establishing cleanup goals that are protective of the Columbia River.

- *Water Quality Standards for Waters of the State of Washington*, (WAC 173-201A-040) for chromium are relevant and appropriate for establishing cleanup goals that are protective of the Columbia River.

11.2.2 Action-Specific ARARs

- *State of Washington Dangerous Waste Regulations*, (WAC 173-303) are applicable for the identification, treatment, storage, and land disposal of wastes determined to be dangerous wastes.

- Land Disposal Restrictions (40 CFR 268) are applicable to the land disposal of wastes determined to be hazardous wastes.

- *Minimum Standards for Construction and Maintenance of Wells* (WAC 173-160 and 162) are applicable regulations for the location, design, construction, and abandonment of groundwater extraction, reinjection, and monitoring wells.

- *Dangerous Waste Standards for Tank System Units* (WAC 173-303-640). The substantive requirements of this are relevant and appropriate to the construction, operation, maintenance and closure of any tanks and associated components (e.g. piping) that contain dangerous waste associated with both the water treatment system and the resin stabilization system.

11.2.3 Location-Specific ARARs

- *National Archeological and Historical Preservation Act* (16 USC Section 469); 36 CFR Part 65, is applicable to recover and preserve artifacts in areas where an action may cause irreparable harm, loss, or destruction of significant artifacts.

- *National Historic Preservation Act* (16 USC 470, *et. seq.)*; 36 CFR Part 800, is applicable to actions in order to preserve historic properties controlled by a federal agency.

- *Public Law 100-605, To Authorize a Study of the Hanford Reach of the Columbia River and for Other Purposes* is applicable to planning, designing, and locating activities in a manner that minimizes direct and adverse effects on the values for which the river is under study. The location of any facilities within 1/4 mile of the river will be coordinated with the National Park Service.

- *Endangered Species Act* of 1973 is applicable to protection of endangered or threatened species. Consultation with the U.S. Department of the Interior will occur as needed.

- *Migratory Bird Treaty Act* is relevant and appropriate to protection of migratory birds in the areas. Consultation with the U.S. Fish and Wildlife Service will occur as needed.

- *Bald and Golden Eagle Protection Act* of 1985 is applicable due to the known roosting of bald eagles in the general vicinity of potential extraction wells. Consultation with the U.S. Department of Interior will occur as needed.

11.2.4 Other Criteria, Advisories, or Guidance to be Considered for this Remedial Action (TBCs)

- *Floodplain Management Executive Order (E.O. 11988)* and *Protection of Wetlands Executive Order (E.O. 11990)* are relevant and appropriate to activities within the floodplains and wetlands. To the extent practicable, actions should avoid or minimize the impact to floodplains and wetlands, and minimize loss due to floods.

- *Environmental Restoration Disposal Facility (ERDF) Waste Acceptance Criteria* (BHI-00139, Rev. 0, October 1995) delineates primary requirements including regulatory requirements, specific isotopic constituents and contamination levels, the dangerous/hazardous constituents and concentrations, and the physical/chemical waste characteristics that are acceptable for disposal of wastes at ERDF.

11.3 Cost Effectiveness

The selected remedy was the most cost effective of the three remedies evaluated that achieved the remedial action objective.

11.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Possible

The selected remedy utilizes permanent solutions. Pump-and-treat using ion-exchange is not an innovative technology.

11.5 Preference for Treatment as a Principal Element

The selected remedy utilizes treatment to concentrate the chromium into a small volume of resin relative to the large volume of treated groundwater. The resin is then solidified into cement. This process reduces the volume, mobility, and toxicity of the chromium.

11.6 CERCLA Section 104(d)(4) Determination

The CERCLA Section 104(d)(4) states where two or more non-contiguous facilities are reasonably related on the basis of geography, or on the basis of the threat or potential threat to the public health or welfare or the environment, the President may, at his discretion, treat these facilities as one for the purposes of this section.

The preamble to the NCP indicates that when non-contiguous facilities are reasonably close to one another and wastes at these sites are compatible for a selected treatment or disposal approach, CERCLA Section 104(d)(4) allows the lead agency to treat these related facilities as one site for response purposes and, therefore, allows waste transfer between such non-contiguous facilities without having to obtain a permit. The 100-HR-3 and 100-KR-4 Operable Units and the ERDF are all contained within the Hanford Site, and are subject to the Tri-Party Agreement. They are reasonably related based on geography, on the basis of the threat or potential threat to the public health, welfare or the environment, and therefore are being treated as a single site for response purposes under this ROD. This is consistent with the determination made in the January 20, 1995 ROD for the ERDF that stated... *"Therefore, the ERDF and the 100, 200, and 300 Area NPL sites are considered to be a single site for response purposes under this ROD."*

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

The DOE, EPA, and Ecology reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments, it was determined that no significant changes to the selected remedy, as originally identified in the Proposed Plans, were necessary. The Proposed Plan for 100-KR-4 identified two contaminants (zinc and carbon-14) for remedial action, that upon more detailed analysis do not warrant inclusion in the interim action.

APPENDIX A - RESPONSIVENESS SUMMARY

Public comments reflected overwhelming support for taking an active pump-and-treat action to prevent plumes from entering the Columbia River. Most of the comments regarded the choice of treatment technique: ion-exchange resin verses other techniques. Regarding the other techniques, comments revolved around reverse osmosis relative to co-contaminants and also other new treatment techniques available by identified vendors.

Ion exchange verses reverse osmosis treatment techniques are discussed in the following comment response. Other treatment techniques are discussed in subsequent comment responses.

Why is the "ion exchange system" method of cleanup preferred to "reverse osmosis"? What are the benefits and advantages of the former over the latter?

First, a brief description of these two methods. Ion exchange requires pumping water through large tanks filled with a resin. Resins are a material to which chemicals tend to stick. Resins are designed to have a tremendous quantity of binding ("sticky") sites. As tanks of resins approach their capacity for contaminants, a progressively higher amount of contaminants pass through without being captured. Generally a number of these ion exchange tanks are plumbed together so that progressively cleaner water can be obtained at each stage. After several treatment steps, the contaminants may be essentially all removed, so large numbers of additional columns provide no added benefit. When contaminants "break-through" the first column, all the binding sites are not yet used. Continued use will eventually nearly saturate the binding sites, resulting in maximal use of the resin. By the time contaminant saturation of the resin in the first tank is nearly saturated, most of the contaminant input is breaking through to the second treatment tank. At that point, resin from the first tank is removed and regenerated for re-use, or disposed. The tank is then cleaned and refilled with fresh resin, and now becomes the final "polisher" tank. The choice of resin determines which contaminants are removed. It is anticipated that a weak base anionic resin bed will be used to capture chromium. Co-contaminants with similar chemical properties would also be retained by this resin (for example: uranium and nitrate). Co-contaminants such as strontium-90 and tritium would not be retained.

Reverse osmosis uses hydraulic pressure to push water through a membrane that is permeable to water but not to the contaminant. Clean water is drawn off from the clean side of the membrane. Water on the "dirty" side of the membrane becomes concentrated with particulate and dissolved contaminants and minerals, and its osmotic pressure rises. Water from the clean side of the membrane is inclined to pass back through the membrane to the dirty side in response to the osmotic pressure, but is held back by the hydraulic pressure applied to the clean side. Ever increasing hydraulic pressure is needed to overcome ever increasing osmotic pressure until the point of diminishing returns indicates that it is time to flush out the slurry on the dirty side of the membrane. The osmotic pressure is reduced and the system again operates productively. In practice, a continuous flow system is usually used rather than the "batch mode" just described.

A major advantage of ion exchange over reverse osmosis is substantially less secondary wastes. With ion exchange, very small volumes of waste resins (relative to the volume of treated water) are generated. With reverse osmosis, relatively large volumes of contaminated liquid are generated. The expense associated with purchase, handling, and disposal of resins is small relative to the treatment and disposal of the solution generated with reverse osmosis. An additional advantage of the ion exchange is that it is a very reliable process. Having a treatment system with minimal down-time is an important element of being protective.

Are the various cleanup sites discrete, or are they interconnected by the same aquifers and affected by the same plumes?

When the three reactor areas covered by this ROD were in operation, they discharged large amounts of water that formed a mound on the former water table. This mound of water flowed in all directions, including upgradient (away from the river) against the natural groundwater flow direction. Thus groundwater in all directions from the reactor areas were initially contaminated with chromium. Following shutdown of the reactors, and an end to the discharge of the liquids, the mound dissipated and groundwater flows have returned to their natural directions. Wells upgradient of the reactors generally still have slightly elevated levels of chromium. In the 100-K and 100-H Areas, the residual chromium remaining in the upgradient portions of the aquifer should gradually be flushed back through the reactor area. However the 100-D Area is unique.

Chromium from the 100-D area that was pushed inland from the historic groundwater mound has in part been pushed into areas that naturally were upgradient of 100-H Area. With the return of groundwater flow to its natural direction, this chromium is in part flushing out towards the 100-H area. With this sketch of the process at work in the 100-D and 100-H Area, the net effect of all the processes at work result in the 100-D and 100-H discharges have mutually affected their mutual "upgradient" area resulting in the whole area having moderately elevated levels of chromium. Within the 100-D and 100-H area are discrete significantly elevated chromium plumes that result in the ecological risk that this ROD addresses. Because this is an interim action ROD, review of these operable units and the remedy will be ongoing as the Tri-Parties continue to develop and implement final remedial alternatives for the operable units and the 100 Area NPL site.

What is the target date of beginning this project?

Design can begin in earnest upon signature of this ROD. Well drilling will begin soon after the ROD. Groundwater extraction and treatment systems at two reactor areas will be operational within 15 months of signature of this ROD. The system at the third reactor area will be operational within 18 months after signature of this ROD.

Once underway, what is the suspected length (time) of the project to completion.

More than a few years. The pump and treat portion of the interim remedial action will continue until the selection of a final action or it is demonstrated to EPA's and Ecology's satisfaction that termination (or intermittent operation) is appropriate because: (a) sampling indicates that hexavalent chromium is below the compliance value, and site data indicate it will remain below the compliance value, or (b) based on an evaluation of the following criteria:

- The effectiveness of the treatment technology does not justify further operation.
- An alternate treatment technique, such as in situ chemical reduction or other improved treatment technique is evaluated and proves to be more effective, and/or less costly, and is consistent with the remedial action objectives.

What is the total amount of water that needs to be pumped?

Water will be pumped at a rate sufficient to capture the chromium plume to an adequate degree to meet the remedial action objectives (see next comment). The total amount of water that will be pumped depends on how long the pump-and-treat system runs (see the previous and next comment).

How much will it cost.

Costs were estimated as part of the feasibility study for this interim action. If the systems were to run for 5 years, the total costs were estimated by DOE to be about 29.8 million dollars. Ecology and EPA believe the project could be designed, operated, and maintained for substantially less than that estimate. Actual costs for the project will be monitored.

What will be the residual levels of contamination at the conclusion of the project; and that would those levels mean in relation to human use or contact with the groundwater.

Residual levels of contamination will be such that the remedial action objectives are met. The remedial action objective for the pump-and-treat aspect of this is to protect ecological receptors in the Columbia River. Protection of human health under this interim action, however, is specifically addressed through institutional controls to limit human access to the ground water.

Is hexavalent chromium the only contaminant being targeted in this project?

As far as active remedial actions, yes. Site institutional controls will continue during the interim remedial action period. These controls limit human access to the groundwater and thereby limit human exposure to groundwater that exceeds drinking water MCLs for a number of contaminants in addition to chromium.

Where will new wells be dug?

New wells will be located within the chromium plumes of the three reactor areas. It is anticipated that these primarily will be located along and inland from the river shore where the main portion of the chromium discharges. A combination of existing and new wells will be used to create a capture zone.

What is the goal of the project? What is clean, and what level of clean is the objective? Are there parameters that define what is safe for salmon eggs and fry, and if so is that the goal? What are EPA's standards for the protection of aquatic life, and are those the goal?

The goal of the pump-and-treat systems is to prevent discharge of hexavalent chromium at levels exceeding concentrations that are considered protective of aquatic life in the Columbia River and riverbed sediments. The aquatic receptor exposure point is within the river substrate at depths up to 18 inches (46 centimeters), where embryonic salmon and fry are present during parts of the year. The relevant standard is the State of Washington's Chronic Ambient Water Quality Standard for Protection of Freshwater Aquatic Life for hexavalent chromium of 11 parts per billion.

Development of site-specific toxicity information on the impacts of chromium to salmon eggs, larvae, and juveniles to support development of site-specific criteria to ensure protectiveness was suggested.

The EPA's AWQC for chromium of 11 μ/L was based largely on toxicity information for embryonic salmon and fry. The EPA's AWQC were used by the State of Washington to establish Water Quality Standards for Surface Waters of the State of Washington. Thus the legal threshold used in this ROD to define protectiveness, although not site-specific, has a species-specific basis. From the remedial action perspective, at this time, DOE, EPA, and Ecology do not consider site-specific toxicity information cost effective in light of other known cleanup needs that would go unfunded if additional bioassays were conducted. (See next comment for the natural resource damage perspective.)

Development of site-specific toxicity information is important for another reason. Impacts from chromium discharges into salmon redds are likely to be one of the more quantifiable injuries to natural resources, and are likely to be a major focus of a damage assessment. The commentor encourages prompt and accurate assessment and mitigation of these potential injuries as advocated by DOE guidance (DOE/EH-0192, page 12) and as required under CERCLA 107(f)(2)(A). The U.S. Fish and Wildlife Service expressed a desire to participate in impact assessment and mitigation planning.

For fiscal year 1996 (FY 96) DOE has initiated an initial scoping level risk assessment in support of the Columbia River Comprehensive Impact Assessment (CRCIA). The FY 96 effort also includes identifying remaining work believed to be needed by the CRCIA management team (comprised of DOE, EPA, Ecology, Tribal, Hanford Advisory Board, and State of Oregon representatives) to perform a "comprehensive" assessment of the Columbia River. The scoping level risk assessment involves determining exposure of a variety of species to a number of Hanford's contaminants in the Columbia River. The contaminants include chromium and the species include salmon. The assessment, the scope of which was agreed to by the CRCIA management team follows EPA guidelines for ecological risk assessment and is designated to support development of interim remedial actions. Based on the FY 96 work, any required mitigation and/or additional assessment needs will be determined. The U.S. Fish and Wildlife Service and other interested parties are encouraged to participate with the CRCIA management team in this assessment and any required mitigation activities.

Construction of extraction wells adjacent to the river has the potential to disturb roosting bald eagles, waterfowl, and terrestrial birds. To minimize impacts of the project, construction activities should be timed to avoid peak periods of bird activity. The U.S. Fish and Wildlife Service indicated a willingness to provide consultation of the most appropriate timing for construction activities.

The DOE will provide the Natural Resource Trustees an opportunity to comment on timing for in-field activities that are potentially disruptive to wildlife. The DOE will consult with the U.S. Department of the Interior and the U.S. Fish and Wildlife Service as appropriate.

The U.S. Fish and Wildlife offered to provide technical support to ensure that revegetation efforts, following the interim action, are technically feasible, appropriately restore disturbed natural resources, and would be compatible with designation of this area as a Wild and Scenic River corridor. It was requested that all the Natural Resource Trustees be consulted early in the revegetation planning. A description of pre-project conditions is necessary if appropriate revegetation is to occur.

Surface disturbance and ultimate restoration associated with these groundwater actions is largely co-located and similar in nature to what will be occurring with the surface waste sites. Revegetation/restoration of surface disturbance associated with actions from this ROD will be addressed as part of the revegetation/restoration of the source operable unit. Natural Resource Trustees will be included in those planning efforts. For areas that are disturbed during construction and operation, it is expected that the area will be revegetated following construction in those areas that are not needed for operation and maintenance of the treatment system and is also not expected to be re-disturbed within the next few years by other site activities. Following completion of the interim action, it is expected that rectification of the habitat affected by this activity will be conducted and coordinated with comparable activities for the source operable units (100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-KR-1, and 100-KR-2).

Planning of pipeline locations should take into account and attempt to avoid higher quality habitat and other important natural resource features.

The ground surface on which these remedial activities will take place is primarily disturbed habitat, due to agriculture and defense related activities. To the extent practicable, areas of higher quality habitat will be avoided or impacts will be minimized.

A number of comments were received from business vendors or technical experts identifying themselves as competent to conduct the work as described in the proposed plan, or to identify innovative techniques that may be better or more cost effective, or to suggest alternate methods to achieve remedial action objectives.

Commitment to a pump-and-treat is a long-term expensive proposition. The Tri-Parties endorse the most cost effective remedial approach consistent with the CERCLA 9 criteria and the remedial action objectives. Evaluation of technologies is an ongoing process with incorporation as deemed appropriate. If in the future a substantially different remedial action approach is considered, public comment will be solicited before a decision to implement it is made. Treatability tests may be conducted without public comment.

There were comments regarding the fact that the proposed plans did not include any action directed at removal of the chromium that is already in the river sediments.

Hexavalent chromium is very soluble in water. Most of the hexavalent chromium is dissolved into and moving with the water. Thus the river bottom sediments to not accumulate hexavalent chromium. When hexavalent chromium is reduced to trivalent chromium, it becomes much less soluble and hence has the potential to accumulate in sediments. However it is also less toxic. Because it is less toxic and in particulate (not dissolved) form, it is generally less bioavailable, and therefore, less of an environmental threat.

A commentor noted his previous experience with ion exchange resins as not being cost effective, part of the problem being that the chromium destroyed the resins. Alternatives such as precipitation were suggested.

There has been considerable experience using resins to treat chromium that have been successful, including a treatability test at 100-HR-3. The resins have not been destroyed by chromium. Precipitation can be cost-effective with very high concentrations of chromium. Generally speaking, precipitation methods are not cost-effective for lower concentrations of chromium, and do not achieve the low concentrations required for this remedial action.

Currently, we plan to dispose of the resins after one use, however if resin regeneration is determined to be practicable, then regeneration may be utilized.

A commentor identified their company's electrocoagulation and electrochemical flocculation process as a remedial alternative.

This process was evaluated in the *100 Area Feasibility Study, Phases 1 and 2* against the following criteria and was eliminated:

- Effectiveness
- Implementability - Technical Feasibility
- Implementability - Administrative Feasibility
- Cost.

A commentor identified that the pump-and-treat system does not capture all the plume, and the treatment train does not remove all the chromium. It was stated that this "does not seem very effective".

It is correct that: (1) plume capture will be partial, and (2) treatment of the water will be partial. But the remedial action objective of this interim action is not to totally prevent chromium from entering the river. The remedial action is intended to capture and treat enough of the chromium that residuals that enter the river are at or below concentrations considered to be protective of the aquatic organisms that inhabit the Columbia River bottom.

A commentor identified that this interim action addresses part of the contaminated groundwater but does not address the remaining groundwater contamination.

Ecological risk is addressed by the pump-and-treat action for the single contaminant that exceeds the ecological-risk based threshold -- hexavalent chromium. Potential human health risks associated with exposure to remaining contaminants are addressed by institutional controls. Thus for the interim period addressed by this interim action, this action should be protective of human health and the environment. Because this is an interim action ROD, review of these operable units and the remedy will be ongoing as the Tri-Parties continue to develop and implement final remedial alternatives for the operable units and the 100 Area NPL site.

Commentors also reiterated another facet of the problem is the previously contaminated soil and the risk that these contaminants pose to surface exposure as well as a continuing to the groundwater.

In addition to the cleanup plan for the 100-HR-3 and 100-KR-4 groundwater operable units, action is being taken to address waste sites that are the historic sources of groundwater contamination. Surface waste sites that are within the 100-DR-1, 100-DR-2, 100-HR-1, 100-HR-2, 100-KR-1 and 100-KR-2 Operable Units received wastes during previous operation of the reactors and their support facilities. Cleanup of waste sites in the 100-DR-1 and 100-HR-1 Operable Units have been addressed in a September 1995 interim action Record of Decision. The 100-DR-2, 100-HR-2, 100-KR-1 and 100-KR-2 Operable Units will be the subject of future Proposed Plans. The 100-IU-4 Operable Unit upgradient of 100-HR-3 includes the former Sodium Dichromate Barrel Landfill, which contained empty crushed barrels that had been used to store sodium dichromate. The 100-IU-4 Operable Unit was remediated in April 1992 through an Expedited Response Action and has been addressed in a previous proposed plan.

While many comments identified that protection of salmon is an effort worthy of this action, it was noted that adverse effects to other wildlife must be considered in this plan.

Aquatic toxicity tests for chromium have been conducted for a wide variety of species, and embryonic salmon and fry are among the most sensitive to hexavalent chromium. The chronic exposure standard used for this remedial action of 11 μ/L hexavalent chromium was established to be protective of aquatic life in general, not just embryonic salmon and fry. Field activities will be conducted in a manner to minimize adverse impacts to wildlife.

The issue of bioaccumulation of hexavalent chromium was identified as a concern.

The criteria and standards for chromium have been established such that the bioconcentration or bioaccumulation of hexavalent chromium that occurs at those concentrations does not endanger aquatic life.

There were comments regarding the disposal of resins contaminated with chromium and other contaminants and the ultimate migration of these contaminants resulting in a future replay of the current problems.

The resins will be treated prior to disposal if necessary to meet the waste acceptance criteria for the Environmental Restoration Disposal Facility. This treatment is intended to reduce the mobility of the contaminants. Hexavalent chromium reacts with the resins resulting in conversion to the less toxic and less mobile trivalent form.

The Nez Perce Tribe comments expressed a request and interest in future involvement in many technical aspects of the conduct of this interim action.

The Tri-Parties intend to continue our policy to consult with affected Native American Indian Tribes on a government-to-government basis. The Tri-Parties will also continue to consult with the Tribes as well as the other Natural Resource Trustees regarding natural resource issues associated with this remedial action.

A number of comments addressed costs associated with the remedial action. Several addressed choosing the most cost effective remedy while others indicated that one cannot put a price tag on the importance of protecting the Columbia River.

This ROD addresses both concerns. The ion-exchange pump-and-treat was identified as the most cost effective remedial action that is protective of human health and the environment. As planned, it also reduces chromium to concentrations that should protect the health of the aquatic system, including embryonic salmon and fry in nests in the river bottom gravels.

A commentor noted that the initial modeling to support remedial design were identified as not to be construed as quantitatively accurate or reliable as indicators of effectiveness or efficiency. This suggests the interim remedial action should be accomplished with design contingency, in order to assure successful remediation.

During remedial design, initial modeling will be refined to better estimate appropriate well positioning for plume capture. Also, as the system comes on line, operational and compliance monitoring will be conducted. When the actual response of the aquifer is known, the design may be altered as needed and approved/directed by EPA and Ecology to meet the remedial action objectives. Contingency in the initial design capacity will be included based on uncertainty in design assumptions.

Interest was expressed in some of the alternate technology testing that was identified in the Proposed Plans for information purposes (are not specifically mandated by this ROD).

Cost effective remedial technologies for groundwater remediation is an active area of practical research. Chromium and other toxic metals are a common problem and are frequently the target of such research effort. Several techniques identified in the Proposed Plans and others not specifically mentioned have been and are under way at Hanford. Many other techniques are being developed and tested at other areas. Should a different technique show promise as a substitute for the ion-exchange pump-and-treat, the Tri-Parties may convert to this method. If this change is fundamentally different than described in this ROD, an opportunity for public comment will be provided.